ELECTRICAL REVIEW

ILLUSTRATED.

A WEEKLY JOURNAL OF

Electric Light, Power, Telephone, Telegraph and Scientific Progress.

VOL. 17, No. 15. WEEKLY.

NEW YORK, SATURDAY, DECEMBER 6, 1890.

$3 per annum. Single Copies, 10 Cents.

Copyright, 1890, by ELECTRICAL REVIEW PUBLISHING COMPANY, 13 Park Row, New York.

Entered at Post Office, New York, as Mail Matter of the Second Class.

A Staten Island Electric Light Station.

At St. George, Staten Island, is situated the plant of the Richmond Light, Heat and Power Company. The officers in command are: Erastus Wiman, president; Samuel Hughan, treasurer; W. Dwight Wiman, general manager; and William Keutgen, secretary. The building occupied as a station is long and low, standing on a gentle declivity which slopes down to the water a short distance below. A smaller brick building adjoining is used for offices, storerooms and repair shop.

At the further end of the long building the boilers are set. These consist of three Root water tube, generating 155 horse-power, three tubular of 160 horse-power and one Morin of 300 horse-power.

The steam plant consists of a 28x60 Hamilton-Corliss engine of 700 horse-power, the fly-wheel weighing 55,000 lbs. and running 75 revolutions to the minute; and five Armington & Sims engines, each of 75 horse-power. The Corliss is placed below the level of the dynamo room floor, a 48 inch Schieren belt transmitting its power to a line of Hill shafting and clutches. The smaller engines stand on the floor of the dynamo room.

The electrical equipment comprises one 1,500, one 1,300 and four 750 light Westinghouse alternators, two 300 light Edisons, two 50 light Thomson-Houston arc machines, two 35 and three 25 American arc machines. About 4,500 incandescent lights are run every night, although the territory covered is wired for about three times that number. Outside of street lights, of which there are about 2,000 incandescents, the remainder is installed in private residences and stores. The price charged is one cent per hour for each 16 candle-power lamp measured by meter, or $18 per year, burning until midnight. Arc lights can be had for 50 cents per night, burning until midnight. Coal costs $2.90 per ton delivered in cars alongside the station.

New Brighton takes 100 arc lights of 1,200 candle-power each for street illumination. When Buffalo Bill, the Kiralfys or any such spectacular show is exhibiting at the nearby Summer resorts, between 200 and 300 extra arc lights are required. The territory lighted by the company is nine miles long and one and a half miles wide. The longest circuit operated is about five miles in length.

The plant has recently been remodeled and rearranged. Several small engines formerly did the work now performed by the big Corliss. This change in steam-power has reduced the coal consumption from 20 to 12 tons per day, notwithstanding an increase in capacity of one-fifth. The dynamo room is well arranged and fitted with all requisite conveniences, including a traveling crane for handling the heavy machines. The switchboard occupies nearly the whole of one side of the room and is of the skeleton type.

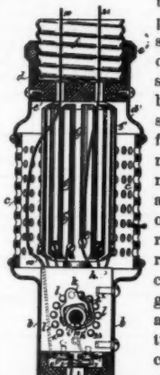
Large developments in electric railway building, in the immediate vicinity, are looked for in the Spring, and this station expects to furnish all or part of the power required. A special steam and electrical equipment will be installed for this purpose.

The company does all its own repairing and finds that it pays. Five or six men are kept busy wiring stores and residences for lights. The business done by the company during the past year went beyond the $50,000 mark.

PROGRESSIVE ELECTRICAL INVENTIONS.

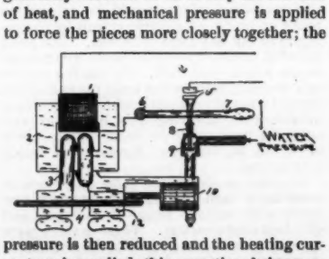
RHEOSTATS FOR INCANDESCENT LAMPS.

In the accompanying engraving is illustrated an improved rheostat, invented by John Doyle, of Hoboken, N. J., for incandescent electric lamps of that type in which the resistance can be gradually increased or diminished so as to vary the incandescence of the filament, or gradually increase the strength of the current circulating through the filament so as to prevent rupture by reason of a sudden influx of current at the moral strength. The chamber in which the rheostat is mounted is perforated with a large number of holes to permit circulation of air and prevent undue rise of temperature in the resisting material. This resisting material is composed of a conglomerate of plumbago and borax laid in longitudinal grooves in a cylinder moulded from pipe clay and retort cement and baked. The layers of resisting material are connected at alternate ends, zigzag fashion, and electrical connections are made at the bends with a series of contacts over which sweeps a spring or brush controlled by the lamp key. As the key is turned in its socket, more or less resistance will be cut into circuit with the filament according to the direction of turning.



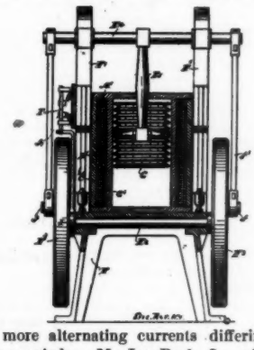
ELECTRIC WELDING.

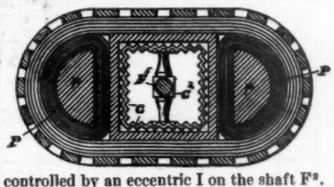
Prof. Elihu Thomson has patented a method of welding, in which the heating current and pressure are alternately applied to the pieces of which a junction is to be formed, until the work is accomplished. The pieces of metal to be welded are placed in conducting clamps in contact with one another, but without any considerable pressure, and a heating current of moderate volume is passed through them; the current is then cut-off or gradually reduced so as to stop the increase of heat, and mechanical pressure is applied to force the pieces more closely together; the pressure is then reduced and the heating current again applied, this operation being continued until a perfect weld is effected. In the accompanying engraving, which illustrates an apparatus designed for carrying out this method, 2 represents a closed magnetic circuit of the transformer, the heavy coil 3 of which supplies a current of proper volume to the clamps in which the pieces of metal 4 are secured. A lever 7 is adapted to open or close the circuit at contact 5. This lever also controls a valve 9 in a water-pressure supply pipe leading to the cylinder 10, so that when the circuit is closed the pressure upon the abutting pieces of metal to be welded is reduced or cut-off and when the circuit is opened the pressure is applied or increased. The repeated and alternate application of pressure and current results in a very perfect weld.

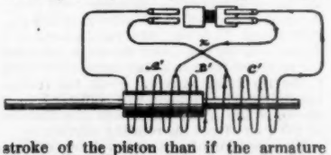


ALTERNATING CURRENT MOTOR.

Most of the alternating current motors hitherto invented depend for their operation upon a traveling polar line developed by two or more alternating currents differing in time periods. Mr. Leo Bock, Jr., of New York, has recently patented a motor in which a single alternating current is used. In the accompanying engravings, which illustrate one form of the apparatus, F represents a base of cast iron upon which is mounted a transformer, the primary coils P of which (see detached view) are connected directly to the alternating current mains. Around the primary coils are wound three sections of secondary coils A^1, B^1, C^1, the terminals of which are connected with a commutator I^1, controlled by an eccentric I on the shaft F^2. The piston F^2 is connected with an iron core G, which is of an expansible nature and rectangular in cross section, as illustrated in the detached figure. It is composed of horizontal iron plates hinged at each end to an adjoining plate, so as to expand and collapse like bellows. At the center of the armature or core is a rigid rectangular frame, to which half of the collapsible core is secured. This construction gives horizontal corrugations intended to increase the surface of the armature. At the end of each stroke the end of the armature or core next the cylinder-head is compressed, thus permitting a longer stroke of the piston than if the armature were rigid. The commutator carries two insulating contacts arranged to bridge alternately a pair of contacts connected with the coils A^1, B^1, C^1, in the manner illustrated in the detached diagram. As shown therein, coils B^1 and C^1 are in circuit and motion will result to the right, during which the commutator will be shifted and the coils A^1 and B^1 cut into circuit, thus producing motion to the left. These actions repeated at each revolution of the fly-wheels cause a traverse of the armature or core alternately in opposite directions, thus preserving the action of the motor.







Electric Ploughing.

An installation for the purpose of ploughing the land by electric motors has been set up on property belonging to the Marquis de la Laguna. The power of a water-wheel of some 20 horse-power will be employed, and the implement for working the land is expected to work at a distance of three miles from the generating dynamo. So far as the electrical plant is concerned all is right, but a deficiency of mechanical and agricultural knowledge on the part of those entrusted with the work seems likely to make this trial a failure. This is much to be regretted, says London *Industries*, as the promoters of the experiment have been fortunate in finding a landowner who is disposed to make a trial of such an important application of electricity.

The Longest Word.

The longest word in the Welsh language has, after a long period of oblivion, been once more exumed. It is Llanfairpwllgwyngllgertrobgllgerchwyrnbyllgogerbwwllzenttvsiliogogogock. This awful word of 70 letters and 22 syllables is the name of a village in Wales. —*Exchange.* It is quite a "long-system" cognomen, to be sure, but how does it size up alongside of "Mpwapwolonembaroggarinomolaulanbumbonogorrokokotomolarembapwapwaggonagollobarigoolokomemwabapwopwokomembaringwapwamwapwo"? This horrific onslaught on the alphabetical capacities is said to be the name of a "city" in Africa, consisting of less than a hundred huts, and ruled by a dusky king. The name is said to signify "Palace of Mpwa, Owner of 100 wives, 50 elephants and 200 slaves, and supreme King over Two Hills and the River Between." Evidently the "short" craze has not yet fallen on African linguistic systems with anything at all resembling the traditional "dull and sickening thud."

Electric Light in the White House.

Proposals were recently asked for by Chief Engineer Williamson, superintendent of the State, War and Navy Building, for the lighting by electricity of that immense structure and also of the White House. When this improvement is completed, it will make the State, War and Navy Building the finest government building in the world. Already $60,000 has been expended by the government in wiring the building. Electricians from all parts of the country are in Washington, and the greatest interest in the matter is manifested. The plant will cost at least $25,000. There are about 1,600 lights used in the State, War and Navy Building.

There are to be about 750 lamps in the White House, and these will make a total of 2,350 lights on the circuit. As the estimate is for a double plant of four dynamos, and the intention is to run but two of them, or one pair, at once, there is thus provision for a total capacity of about 2,880 lamps. The White House will need its illumination only at night, possibly excepting a few lamps in the offices.

Superintendent Williamson is anxious to have the plant ready for operation by January 1st, so as to be able to turn on the current for the New Year reception. According to the advertisement, the goods are to be delivered on or before December 10th, and the plant is to be in working order by the last day of December.

The bill of complaint of J. H. Rodgers against ex-Attorney General Garland and others, involving the ownership of Pan-Electric Telephone and Telegraph stock, was dismissed in the Court of General Term, at Washington, D. C., on November 25th.

Electrical Oscillations in Air.

BY PROF. JOHN TROWBRIDGE, OF HARVARD, AND W. C. SABINE, BEFORE THE AMERICAN ACADEMY OF ARTS AND SCIENCES.

The experiments of Hertz on electrical waves have opened a wide field for investigations in electro-magnetism. The qualitative results of Henry and of Feddersen have been expressed in a quantitative manner by Sir William Thomson. Hertz, collecting together the results of previous observers, and reasoning upon the factors in the formula of Sir W. Thomson—which expresses a relation between the capacity of a Leyden jar and the self-induction of the circuit through which this jar is discharged—has detected wave motion with its nodal points and ventral segments, on a wire over which electrical oscillations take place.

Hertz has also pointed out that the experimental results confirm Maxwell's theory, that light and heat are electromagnetic phenomena, and that all energy comes to us from the sun in electrical pulsations.

There can be no question of the phenomena of so-called resonance discovered by Hertz. Roughly speaking, the results obtained by Hertz's resonators satisfy the formula, $t = 2\pi\sqrt{LC}$. In which t is the period of the electrical oscillations, L is the inductance of the circuit, and C is the capacity of the jar, or that of the terminals between which the electrical discharge takes place.

Prof. J. J. Thomson has based a method of measuring the capacities of dielectrics upon this formula and upon Hertz's work.*

The researches of Feddersen upon electrical oscillations† were more quantitative than those of Joseph Henry; and Lorenz,‡ by his repetition of Feddersen's results, and by his mathematical analysis of them, apparently gave subsequent observers a solid basis for calculation.

The results of Feddersen and of Lorenz were obtained by photography. An image of the electric spark drawn out by means of a revolving mirror was photographed, and the distances between the successive oscillations, shown by dark bands on the photograph, were measured. Lorenz assumed the ratio between the electrostatic units and the electromagnetic units, $v = 300\times10^6$ m., as that of the velocity of light; and by means of the formula $t = \frac{2\pi}{v}\sqrt{LC}$ obtained a satisfactory agreement between the result of experiment and the theory. He showed, apparently, that a certain lack of agreement between theory and experiment, which Feddersen had noticed, was due to taking the dielectric constant of glass too small.

It will be noticed that the method of Feddersen, by means of which the electrical oscillations are photographed, apparently affords an accurate method of determining v. For the factors L and C occur under the square root, and the percentage errors of determination of L and C, being under the square, are halved. Lorenz did not repeat the entire work of Feddersen, but only obtained a sufficient number of photographs—taken under definite conditions in regard to capacity and inductance of the circuit—in order to measure t, the time of oscillation. The accuracy of the results which can be obtained for v depends upon the limits of accuracy of the measurements of the photographs, and of the determinations of the dielectric capacity for oscillatory charges.

In reasoning upon the mode of electrical oscillations in dielectrics, it occurred to us that the medium of the dielectric must greatly influence the result. At the instant the electrical oscillations occur, the glass of the Leyden jar is subjected to a strain which is more or less periodic. It is not probable that the capacity of a condenser is the same for rapid charges and discharges as for slow ones, and the measurements of capacity by the ordinary slow methods form no criterion of the capacity of glass under electrical influences which last but three-millionths of a second. We, therefore, concluded to employ an air condenser instead of one of glass, in order to detect, if posible, the effect of the medium of the dielectric upon electrical oscillations. In order to obtain sufficient capacity for a suitable spark, we were obliged to use the cylindrical form of condenser. The first condenser we employed was made of sheet zinc, and consisted of 19 coaxial cylinders. The inner cylinder had a diameter of 15.1 cm., and the outer, one of 60.4; the height of the cylinders was 92 cm. The capacity was computed from the formula

$$C = \tfrac{1}{2}\frac{l}{\log\frac{b}{a}};$$

in which l is the height, and b and a are radii.

A correction for the ends was made as follows: The radius of curvature of the boundary of the cylindrical plates was considered so large in comparison with the distance between them that the boundary was treated approximately as a straight line.

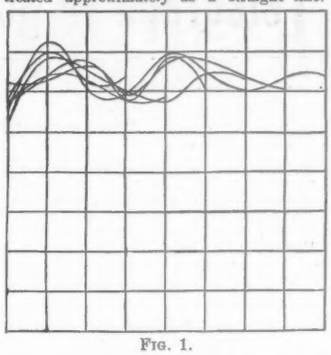


FIG. 1.

We may consider that each zinc cylinder constituted a plate between infinite imaginary planes which were at zero potential, these planes being equipotential surfaces. The zinc cylinder was supposed to have its area extended by a strip of uniform breadth around its boundary, and the surface density was assumed to be the same on the extended plate as on the parts not near the boundary. Following Maxwell (vol. i, sec. 196), we have

$$\frac{B}{\pi}\log_e 2\cos\frac{\pi\beta}{B}$$ for the correction for length.

$B = a - b$ = distance between cylinders.

β = thickness of cylinder.

l = height of cylinder.

This air condenser was connected with a circuit of parallel wires, which was carefully strung by means of silk thread through the center of a large unoccupied room. The length of this circuit was about 50 feet. It returned upon itself to the sparking terminal of the air condenser. The jar was charged by a Holtz machine, which worked fairly well under all conditions of the atmosphere. The revolving mirror was a plane one, 4 x 5 inches, silvered upon the front face. It revolved upon a horizontal axis with an average speed of 3,000 revolutions per minute. The frame which carried the mirror bore also a brass arm provided with a minute brush, which rubbed upon a brass sector let into a large disk of ebonite. When the brush rested upon the brass disk, the electrical charge could pass to two terminals of tin, between which the discharge took place. A concave silvered glass mirror, of 313 cm. radius and 16.5 cm. aperture, placed at a distance of 230 cm. from the spark, received the image of the spark and reflected it back to the revolving mirror. From the revolving mirror the image was reflected to a photographic plate, which was at a distance of 259.7 cm. from the rotating mirror.

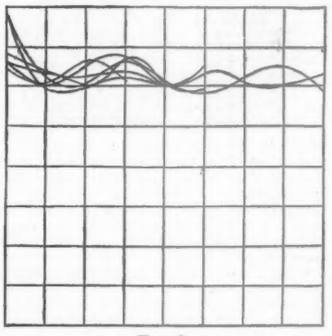


FIG. 2.

The adoption of a plane revolving mirror, and a stationary concave mirror of long focus, enabled us to place the photographic plate at a distance from the revolving apparatus, and, therefore, to employ less speed for the revolving mirror. There was no sensible aberration of the image. Great care was taken to balance the mirror. Its large size and weight made it very important, on account of the danger of the apparatus flying apart, that it should revolve with uniformity. The axis of the mirror was placed horizontally. This precaution proved to be a wise one, for twice during the course of the many runs which were made the mirror flew into pieces; the excursions of the fragments, however, were confined to a vertical plane. This liability to accident is, perhaps, inherent in a method which employs a large plane mirror. The increased amount of light which results from the use of a large mirror, however, forms a valuable compensation. The revolving mirror was driven by a gas engine.

In order to determine the speed of the mirror at the instant the spark passed, the following apparatus was devised. The same shaft which carried the revolving mirror also carried a brass cylinder of 5 cm. in diameter and 21 cm. long. This cylinder was covered at each trial with paper which was coated with lampblack. A stylus moving along a stationary rod beside the shaft could be made to draw a spiral upon the revolving cylinder. One terminal of the Ruhmkorf coil was connected with the brass cylinder and the other with the stylus. A second pendulum was made to break the circuit of the primary of the Ruhmkorf coil at intervals of one second, and at the middle point of its swing. When the stylus was drawn along the stationary rod which served to guide it, it was made to release automatically at the beginning of the second another pendulum held up by an electromagnet. This latter pendulum, at the middle of its swing, discharged the air condenser through the inductance circuit at the instant that the mirror was in a suitable position to reflect the image of the electric spark into the photographic camera. While the stylus was being drawn upon the revolving cylinder, the spark from the Ruhmkorf coil left its trace upon the blackened paper. The record on the chronograph consisted of a strongly marked spiral line of over 50 turns. The two sparks from the Ruhmkorf coil left their trace upon the blackened paper or spires, which, therefore, measured the number of revolutions of the cylinder between the swings of the pendulum, and

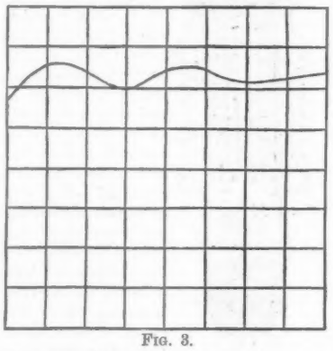


FIG. 3.

thus gave the rate at which the mirror was revolving. The chronograph record enabled us to measure the time to $\frac{1}{500}$ of a second.

In any operation which requires that an electrical spark should make a record upon a disk or cylinder revolving at great speed, a large Ruhmkorf coil and a strong battery are necessary, especially if the primary circuit of the Ruhmkorf coil is broken by a pendulum. With the ordinary automatic break, such as is commonly employed upon induction coils, the failure of a single break is unimportant. If, however, a single break fails when a pendulum break is employed, the record of the experiment is an imperfect one. An excess of battery power and a large battery are, therefore, necessary. A metallic break-piece, also, was found to be more inconstant for our purposes than a mercury break.

It was found that a certain simplicity of contrivance was necessary in the method of discharging the air condenser through the inductance circuit. No arm connected with the revolving mirror could be trusted to make or break an electric circuit by throwing in or out any form of switch. The great speed at which it revolved broke all arrangements which were tried. By placing a short stiff brush of minute size upon the end of the flying terminal connected with the revolving mirror, and allowing this brush to rub against a brass plate set in an ebonite circle of 41 cm. in diameter, constancy of action was secured.

In order to obtain the same difference of potential at each run, experiments were first made with various forms of unit jars and pith ball electrometers. These devices were speedily given up in favor of a simple balance electrometer. One of the pans of a delicate balance was replaced by a metallic disk. A similar disk, which was stationary, was placed immediately below the movable one. By properly weighting the remaining balance pan, great delicacy and range of indication were obtained. This apparatus constitutes, in fact, an absolute electrometer. A suitable guard ring can be placed around the movable disk.

When the air condenser has been charged to a definite potential, the movable disk of the electrometer closed an electrical circuit, in which was included an electrical bell. The observer stationed at the chronograph, at the instant he heard the bell, drew the carriage connected with the stylus along the

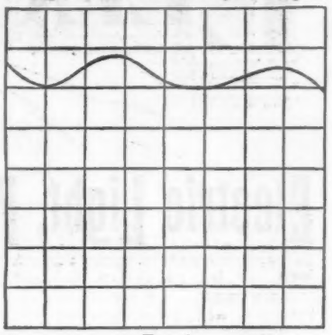


FIG. 4.

guides which kept the stylus on the blackened cylinder.

Calling L the co-efficient of self-induction, we have

$$\frac{L}{l} = 2\log\frac{b}{a} + 1,*$$

in which l is the length of conductors contained between two parallel planes; b, the distance apart of the conductors; a, the radius of the wires.

In our case, the effect of the ends was found to be inappreciable. The induction due to the ends can be calculated by the repeated employment of the formulas for geometric mean distance† for two lines whose directions intersect at right angles.

Lord Rayleigh has given the following formula for inductance under rapid oscillations:

$$L' = l\left(A + \sqrt{\frac{\mu R}{2\rho l}}\right);$$

in which A is a constant, depending on form of circuit; μ is permeability; R is resistance;

$$\rho = \frac{2\pi}{t},$$

where t is time of oscillation; l is length to and fro of inductance circuit.

The final value of L' for our case is $L' = 39697$.

The radius of the wire employed was $a = .0501$ cm.

The length was measured in three sections:

No. 1, length 1197.0 cm. distance between wires $b_1 = 31.55$ cm.

No. 2, length 281.0 cm. distance between wires $b_2 = 16.1$ cm.

No. 3, length 103.0 cm. distance between wires $b_3 = 11.3$ cm.

The ohmic resistance of the wires was $.742 + 10^9$ for direct current, and $1.54 + 10^9$ for alternating currents of period $t = .0000031$.

The difficulty in the process of photographing the spark consisted in discharging the air condenser through the induction circuit at the instant the revolving mirror was in a position to reflect the image of the spark to the photographic plate. The terminal connected with the revolving mirror, which allowed the electrical discharge to pass when the mirror was in the desired position, had to be adjusted with extreme care. The speed of the image at the photographic plate was about one mile per second.

The photographs were measured by means of a dividing engine. At first, an objective

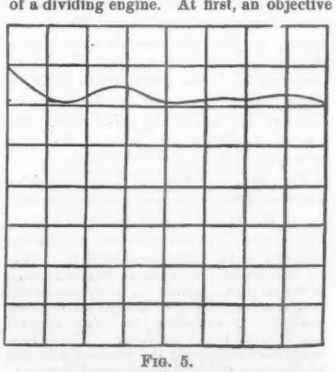


FIG. 5.

of low power was used on the microscope of the dividing engine. It was found, however, that a simple cross hair, unaided by a lens, moving directly against the negative, was better than any eyepiece. Measurements were made of the intervals between the electrical oscillations at both terminals.

In later experiments a smaller air condenser was employed, for reasons which

* Proceedings of the Royal Society, June 20, 1889.

† Poggendorff's Annalen, vol. cii. p. 69, 1858; vol. cviii. p. 497, 1859; vol. cxii. p. 452, 1861; vol. cxiii. p. 437, 1861; vol. cxv. p. 336, 1862; vol. cxvi. p. 132, 1862.

‡ Wiedemann's Ann., vol. vii. p. 161, 1879.

* Maxwell, § 685, vol. ii.

† Maxwell, § 692, vol. ii.

will appear in the conclusion of our paper. A summary of the details and dimensions employed is given herewith.

Small air condenser (No. 2), cylindrical.
19 zinc cylinders.
Height, 30.47 cm.
Diameter of inner cylinder, 7.60 cm.
Diameter of outer cylinder, 25.95 cm.
Average distance apart, .5 cm.
Capacity (geometric), 5317.9 absolute units—corrected for the capacity of ends.
Capacity of wire, 200.

Self-induction, in three sections, radius, .0501.
1. Length 1197.
Distance apart of parallel wires, 31.55.
2. Length, 281.
Distance apart, 16.10.
3. Length, 103.
Distance apart, 11.3.

For alternations of slow period.
Ohmic resistance, .742.
Self-induction, 41090.
Theoretical time with these values, .00000310 sec.

For alterations of period, .00000310 sec.
Ohmic resistance, 1.54.
Self-induction, 39700.
Theoretical time, .00000304.

Distance from spark to concave mirror, 230 cm.

Distance from rotating mirror to negative, 259.7 cm.

Sparking distance, .23 cm.

The following is a sample record (see Figs. 5 and 6). Each negative was measured three or more times, and the mean taken. The lengths are given in centimetres. The last line is the time in millionths of a second.

RIGHT TERMINAL.

.289	.541	.561	.598	.553	.511	.544	.560	....
.295	.528	.560	.595	.542	.542	.550	.585	.492
.290	.528	.582	.602	.518	.538	.550	.573	.532
.292	.518	.585	.592	.540	....	....	....	....
.291	.529	.572	.597	.540	.528	.549	.572	.512
1.65	3.00	3.24	3.38	3.06	3.00	3.11	3.24	2.90

LEFT TERMINAL.

.461	.611	.582	.522	.508	.551	.554
.464	.609	.567	.543	.500	.585	.556
.462	.607	.574	.532	.592	.570	.542
.462	.609	.574	.532	.503	.569	.551
2.62	3.45	3.25	3.01	2.85	3.22	3.12

Number of revolutions per second, 54.06.

Length of spark, .23 cm.

The discharge of a glass Leyden jar gave the following values, when reduced to seconds, different lengths of spark being used.

Length of Spark.	Terminal.	Time of Successive Oscillations.						
.4 cm.	Right	1.66	3.23	3.30	3.44	...	...	
	Left	3.33	3.37	3.30	3.36	...	...	
1.3 "	Right	1.71	3.32	3.45	3.37	3.42	...	
	Left	3.30	3.43	3.42	3.43	3.42	3.50	

Fig. 7 shows that the length of the spark exerts an inappreciable effect.

The following table gives the values in millionths of a second of the successive oscillations on six negatives taken with small air condenser under the conditions given on the preceding page. The first on the right terminal is a half oscillation. The rest are double oscillations.

RIGHT TERMINAL.

1.65	3.00	3.24	3.38	3.06	2.91	3.11	3.24	2.90
1.68	3.22	2.99	3.35	3.03	2.97	....	....	....
1.90	3.11	3.01	3.31	3.00	3.29	....	....	....
1.95	2.95	3.00	3.08	3.00	3.20	3.03	3.03	3.16
1.62	3.01	3.34	3.04	....	....	....	....	....
1.64	3.18	3.14	3.18	3.03	....	....	....	..
1.74	3.08	3.12	3.22	3.04	3.09	3.07	3.13	3.03

LEFT TERMINAL.

2.62	3.45	3.25	3.01	2.85	3.22	3.12	.....	.....
2.89	3.50	3.08	3.21	....	....	....	....	....
3.11	3.12	3.30	2.96	3.35	2.39	3.16	3.06	....
2.75	3.63	3.02	2.97	3.48	3.22	3.00	3.18	3.19
2.84	3.19	3.36	2.89	3.41	3.00	....	....	....
2.88	3.19	3.13	2.90	2.96	...	....	....	....
2.85	3.39	3.19	2 99	3.21	3.21	3.09	3.12	3.19

The values for the different negatives are are plotted in Figs. 1, 2; the mean values in Figs. 3, 4. The time of the first half oscillation was doubled in plotting. On each ordinate is plotted the time of one oscillation—on the first ordinate the time of the first oscillation, on the second the time of the second. It should be noted that the curved lines are meaningless, except where they cross the vertical ordinates, serving merely to connect the points belonging to one negative.

The difference in the time of oscillations cannot be explained by the vibration of the discharging arm lengthening and shortening the sparking distance, since this would necessitate a vibration frequency of 100,000 per second, and an amplitude of at least one millimetre; a velocity and momentum impossible for the apparatus either to acquire or endure. This cause also would tend to make the vibration range equally above and below the calculated value as the sparking distance increased or diminished.

Another explanation may be sought in the varying ohmic resistance of the path of the spark, although this explanation is inadequate to explain the whole effect. In order to test it, a long (1.3 cm.) and short (.4 cm.) spark were taken from a glass Leyden jar (see Fig. 7). Not only could no appreciable difference between the two plates be detected, but there was no variation in the time of successive oscillations.

In regard to the measurement of the negatives on the dividing engine, the following points may be worthy of mention. At the time the measurements were made it was expected that the sparks from the glass condenser would show the variations, and that the air condenser would give the constant and theoretical period of oscillation. The reverse of this appeared when the results of the measurements were reduced. Moreover, the measurements were made by a run of the dividing engine from one end of the negative to the other, so that if an error was made in the setting of the crosshair on the image of one discharge—for example, making the measurement of that oscillation large—a corresponding amount would be deducted from the measurement of the next oscillation. The result of this would be, that if the apparent variations were due to errors in measurement, the periods of discharge would be alternately large and small, or, at least, as often as far below the theoretical value as above it. But this is conspicuously not the case.

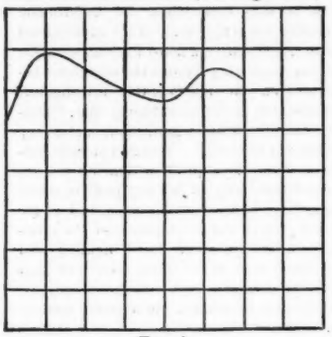


FIG. 6.

A consideration of the curves which represent our results, shows that with quick oscillations which result from the employment of a small air condenser, the air dielectric did not have time to recover completely, in the time of one oscillation, from the strain to which it was subjected. With the larger air condenser, the oscillations being slower, more time was given for this recovery, and hence the periodicity which we have discovered was not so marked. It seems, therefore, that not only should an electrical resonator be turned for capacity and self-induction, but also for a certain periodicity of strain in the dielectric.

In the case of glass, we should not expect to obtain evidence of this periodical recovery from a quick strain, since it is well known that the recovery from strain is so slow that the discharge from a Leyden jar is incomplete after a discharge lasting a second. The curve we give for glass (Fig. 7) shows that this periodical recovery is too slow to manifest itself during the time of quick oscillation.

It is perhaps unnecessary to call attention to the fact that the capacity of a dielectic for rapid discharges is very different from its capacity for slow discharges. In the paper of Lorenz, already cited, the value of the dielectic capacity of glass was determined by slow methods, and used to test an equation in which the capacity of glass appears under very rapid charging and discharging.

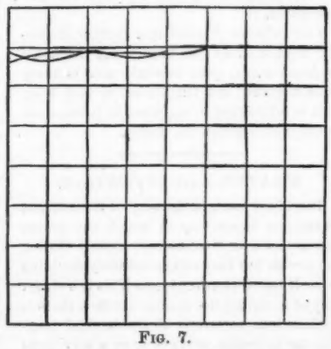


FIG. 7.

Boltzman* and Klemencin† have experimented on the specific inductive capacity of gases and vapors, and it is seen from their results that the agreement between the square root of the capacities of the simple gases and μ, the index of refraction for light of these gases, is quite close, as is demanded by Maxwell's electromagnetic theory of light. A marked difference, however, was found to exist in the case of more complicated molecules—sulphurous acid, or ethyl bromide, for instance. It is probable that the changes of specific capacity of heterogeneous media under rapid alternating forces constitute an important factor in considering the possible agreement between Maxwell's theory of light and the results of experiment.

In order to see if an intense magnetic field could modify the transmission of electrical waves through a dielectric, the following experiment was tried. A glass Leyden jar, 2.5 cm. in diameter and 28 cm. in height, connected with our inductance current, was placed inside a coil consisting of 728 windings of large wire. The outer and inner radii of this coil were 37.7 cm. and 34 cm. Its height was 40.5 cm. The magnetic field in this coil was approximately 30 amperes. It was expected that a certain amount of the energy spent in producing the electrical waves would be consumed in a reaction on the magnetic field. The total duration of the electrical discharge did not appear to be notably affected by the magnetic field. Certain experiments seemed to show a decrease in the total number of electrical oscillations. A large number of experiments will be necessary to decide upon the effect of a magnetic field upon the passage of electrical waves through a dielectric. The difficulty of obtaining an electrical discharge under the same difference of potential made the experiment an extremely difficult one. The method seems to us to promise a discovery of Maxwell's displacement currents in dielectrics; and we are, therefore, continuing our researches in this direction with a modified form of apparatus.

CONCLUSIONS.

1. The electrical oscillations in the air between the plate of an air condenser show a periodicity extending through the entire range of oscillations. We believe that this periodicity is the analogue of the phenomenon of hysteresis in magnetism. A certain amount of the energy of the electrical discharge is spent in overcoming the dielectric viscosity of the air, and in straining the air dielectric. This strain is not immediately released in unison with the electrical surgings.

2. The discussion of our entire results shows unmistakably that electrical oscillations in air are not represented fully by the theoretical equations employed by Hertz. Since the latter writer has taken the term *resonance* from the subject of acoustics, and has given it a new significance in relation to electrical waves, we are tempted to draw also an analogy from the subject of sound. Laplace showed that the discrepancy between the value for the velocity of sound in air calculated from the theoretical equation, and that obtained by experiment, was due to a transformation of energy in heating and cooling the air during the passage of the sound wave. Our experiments on the transmission of electrical waves through the air show also that the values calculated from the theoretical equation do not agree with the experimental values. The discrepancy, we believe, can be explained also by a consideration of transformations of energy in the dielectric.

3. The periodicity which we have studied is most manifest when the variable capacity of the air condenser bears a suitable relation to the time of the electrical surgings.

4. The electrical waves are apparently unaffected by passing through glass which is placed in an intense magnetic field, the direction of the electrical strain being perpendicular to that of the magnetic strain. The displacement currents of Maxwell in this case do not appear to affect the time of electrical surgings. This conclusion, however, may be modified by experiments which we shall try on a more extended scale.

*Pogg. Ann., vol. cli. p. 403, 1875.

†Abstract of Journal of the Society of Telegraphic Engineers, 1886, p. 108.

President Roberts' Life Saved by Negligence.

The negligence of a telegraph operator in the employ of the Pennsylvania Railroad at Pittsburgh, last week, saved the life of President George B. Roberts. Some important business involving the Western connections of the railroad demanded Mr. Roberts's presence in Pittsburgh on Friday last. He expected to start for Pittsburgh Thursday evening, and had ordered his private car to be made ready to be attached to the first section of the Western express, leaving Broad street station at 9.20 at night. All that afternoon he anxiously awaited a despatch from Pittsburgh informing him that all arrangements had been made and that he was to come on, but no message having been received up to 3 o'clock, he concluded that his presence was not required after all, and therefore countermanded the order for the preparation of his car.

If President Roberts had taken the train, as originally intended, his car would have been the first one to be smashed in the New Florence collision. The construction of his car is such that he could not have escaped instant death. His private bedroom is near the rear of the car, and the locomotive of the rear train would have crushed him beyond recognition in an instant.

The careless telegraph operator, who found the despatch addressed to President Roberts just as he was about to go home on Thursday night and filed it under the impression that he had sent it, has not yet been discharged, and assurance has been conveyed to him that his position is secure for the present.—*Philadelphia Inquirer.*

Philadelphia, Pa.—Diamond Electric Company; capital, $250,000.

Titusville, Fla.—The Titusville Electric Light Company; capital, $3,000.

Madison, Wis.—Columbus Electric Light and Power Company; capital, $20,000.

Findlay, O.—The Findlay Electric Light and Power Company; capital, $150,000.

Canon City, Col.—Canon City Electric Light and Power Company; capital, $30,000.

Spartansburg, S. C.—Spartansburg Electric Light and Power Company; increase of capital stock to $75,000.

Waterbury, Conn.—Standard Electric Time Company; increase of capital stock from $25,000 to $35,000.

Kittanning, Penn.—Kittanning, Penn., Electric Light Company; increase of capital stock from $12,000 to $30,000.

Milwaukee, Wis.—Johnson Electric Company amended articles, increasing capital stock from $150,000 to $200,000.

Batesville, Ark.—The Batesville Water & Electric Company; capital, $100,000. The officers and directors are: Samuel B. Hartz, president; John W. Hamilton, John F. King and Isaac V. Read.

Philadelphia, Penn.—The Spring Garden Electric Company; capital, $10,000. Directors, Aaron Fries, Jos. J. Martin, Dr. L. S. Filbert, Ed. J. Houston, James McManes, R. N. Corson, Ernest B. Davis.

Albany, N. Y.—The Troy Telephone and Telegraph Company; capital $250,000. The shareholders are Frank W. Sabold, Albany; George P. Ide, Abram Belcher, Troy; and Walter C. Humstone, Brooklyn.

Chicago, Ill.—The Electrical Machine Company, to manufacture and deal in electrical machines and appliances, etc.; capital, $5,000. Incorporators, Everett S. Tomlinson, Henry A. Caldwell and John L. Flatery.

Baltimore, Md.—The Donaldson-Macrae Electric Company, for the manufacture of all kinds of electrical machinery. Incorporators, Wm. W. Donaldson, Roderick Macrae, Francis Donaldson, Wm. Winchester and Alexander H. Robertson. The capital stock is $20,000.

The Electric Light Plant in the Ashland Mine.

The Westinghouse Electric and Manufacturing Company has just completed the installation of an electric light plant in one of the iron mines of the Lake Superior district. The mine is called the Ashland, owned by the Ashland Iron Mining Company, of Ironwood, Mich.

There are over 2,000 people occupied in the mine, which is one of the oldest and richest in the Ironwood mining district, Like most of the mines in the Lake Superior iron ore belt, the Ashland is in some portions considerably damp, and the installation of an electric lighting plant presented, therefore, a great many difficulties, owing to the trouble of accomplishing a thorough insulation of the wires.

The Ashland mine is 720 feet deep and has eight layers. The descent into the mine is made by means of a number of ladders, each of them being 75 feet in length. The dampness in some parts of the mine was extraordinary, and to succeed in making the insulation perfect the wiring had to be drawn through Simplex insulating paint, and only the best Okonite was used in the entire plant. The work could only proceed very slowly owing to these obstacles, and it took four months to finish the construction of the wiring.

The generating station of the plant is situated in the pump-house. The plant has a capacity of two 300 light Westinghouse machines. The switchboard is very artistically arranged, and is made of a beaten board of white and brown birch wood.

ELECTRICAL REVIEW

Published at 13 Park Row,
P. O. Box 3329. NEW YORK.

EDITORS:
GEO. WORTHINGTON. CHAS. W. PRICE.
ASSOCIATE EDITORS:
ROBT. H. READ. STEPHEN L. COLES.

BUSINESS STAFF:
GEO. WORTHINGTON, President. CHAS. W. PRICE, Secretary.
ROBT. H. READ, Manager Patent Bureau.
H. T. RICHARDS, Mgr. Advertising Department.

BOSTON OFFICE:
W. I. BARKER, Room 29, 620 Atlantic Ave.
WASHINGTON OFFICE:
GEO. C. MAYNARD, 1409 New York Ave.
CHICAGO OFFICE:
D. B. DEAN, 163 Randolph Street.
EUROPEAN OFFICE:
CHARLES FFRENCH, Bridge House, 181 Queen Victoria St., London, E. C.

REGISTERED CABLE ADDRESS:
"ELECTVIEW," NEW YORK.

"1546 CORTLANDT," TELEPHONE CALL.

SUBSCRIPTION TO THE
ELECTRICAL REVIEW.

One Year, United States and Canada, - $3.00
One Year, Foreign Countries, - - 5.00
Single Copy, - - - - .10

ANNOUNCEMENT.

Address all communications and make all money orders and checks payable to order of ELECTRICAL REVIEW, P. O. Box 3329, New York.

No attention will be paid to communications for the REVIEW without the *name and address of the writer.*

NEW YORK, DEC. 6, 1890.

CONTENTS.

	PAGE.
A Staten Island Electric Light Station	175
Progressive Electrical Inventions	175
Electric Ploughing	175
The Longest Word	175
Electric Light in the White Houre	175
Electrical Oscillations in Air	176
President Roberts' Life Saved by Negligence	177
New Corporations	177
The Electric Light Plant in the Ashland Mine	177
Municipal Control of Electric Light Companies	178
Wanted.—An Invention	178
The Light of the Future	178
Correspondence:	
Our Boston Letter	179
Our Chicago Letter	179
Personal	179
The Light of the Fire-Fly	179
Telephonic News	180
Lecture by Mr. Carty	180
A Quick Transfer of a Telephone Exchange	180
A Telegraph Pole as a Storehouse	180
What is "Earth"?	180
The Primordial Germ of the Telephone	180
Electricity in Switzerland	181
A False Alarm	181
About Lightning Strokes	181
Royal Society	181
A Christmas Holiday Tour	181
For Amateur Electricians	181
The Westinghouse Snow Plow	181
Telegraphic	181
Electric Power	182
Our London Letter	182
Electric Heater for Cars	183
Electric Light News	183
The Trolley in Boston	184
The Foote Speed Regulator	184
New Conduit System	185
Electric Lighting at Monaco	185
Electric Clubs:	
New York Electric Club	185
Wisconsin Electric Club	185
American Chemical Society	185
Ball Lightning	185
Kindred Interests	186
Electric Lighting at St. Pancras	186
Storage Battery Combine Denied	186
Financial	186
Electrical Patents	186

INDEX OF ADVERTISERS.

COVER PAGES.

	PAGE.
Ansonia Brass & Copper Co	xxiv
Armington & Sims	xxiv
Bridgeport Brass Co	xxiv
Brush Electric Co	xxiii
Davis, Charles H., Electrical Engineer	xxiv
Day's Kerite Insulated Wires	xxiv
Eastern Electric Cable Co	xxiv
Eddy Electric Mfg. Co	ii
Hampson & Co., E. P.	xxiv
Jewell Belting Co	xxiv
Moore, Alfred F	xxiv
Okonite Co	xxiv
Simplex Electrical Co	xxiv
Standard Underground Cable Co	xxiv
Tucker Electrical Construction Co	xxiv
Wilmot & Hobbs Manufacturing Co., The	xxiv

INSIDE PAGES.

Alexander, Barney & Chapin	xvi
American Bell Telephone Co	xv
American Circular Loom Co	iii
American Electrical Works	xiii
Baker & Co	xiii
Ball Electric Light Co	xv
Barnes Co., W. F. & John	vi
Baxter, H. E. & C	xvii
Bishop Gutta-Percha Co	vi
Brownlee & Co	vii
Buckeye Engine Co	xi
Burton Electric Co	xiii
"C. & C." Electric Motor Co	vii
Central Electric Co	xix
Chadbourne, Hazelton & Co	xviii
Consolidated Electric Storage Co, The	vi
Crocker-Wheeler Motor Co	xi
Crosby Electric Co	xii
Delany, Patrick B	186
Dwight Slate Machine Co	xvii
Eastern Electric Construction & Supply Co	xx
Eastern Plaster Board Co	vi
Edison General Electric Co	xxi
Edison Manufacturing Co	v
Electric City Co., The	ix
Electric Construction and Supply Co	xx
Elektron Manufacturing Co	xiv
Empire China Works	iii
Empire City Electric Co	xxii
Eugene F. Phillips Electrical Works, Ltd	xiii
Faraday Carbon Co	xvii
Field Engineering Co	x
Fletcher & Fletcher Electric Co	186
Fort Wayne Electric Co	xxii
Foundry and Machine Department Harrisburg Car Mfg. Co	xv
Garvin Machine Co	vi
Gate City Electric Co	xix
Goodyear Hard Rubber Co	iv
Gordon & Co., W. H	xiii
Great Western Electrical Supply Co	xx
Greeley & Co., The E. S	x & xvii
Heisler Electric Light Co	x
Hill, Warren S	x
Holmes, Booth & Haydens	xiv
Holtzer-Cabot Electric Co	vii
India Rubber Comb Co	iv
Indurated Fibre Pipe Co	xiv
Industries	xviii
Independent Bung Co	xiv
International Aluminum Works	xiii
Laird & Lee	xviii
Lane & Bodley Co	vii
Law Telephone Co	186
Leclanche Battery Co	xiii
Leffel & Co., James	xvii
Lehigh Valley Creosoting Co	xiii
Maguire, F. Z	186
Marshall, Wm	xiii
Messner, C. W	186
National Carbon Co	vii
National Electric Mfg. Co	iv
National Electrical Mfg. Co	x
Newark Machine Tool Works	xiii
New England Butt Co	iii
New York Belting and Packing Co	xvii
New York Insulated Wire Co	xviii
Noye Mfg. Co., John T	vi
Otis Bros. & Co	v
Ostrander & Co., W. R	xvii
Page Belting Co	xv
Paillard Non-Magnetic Watch Co	xv
Parker-Russell Mining and Manufacturing Co	xvii
Perkins Electric Switch Mfg. Co	xv
Phœnix Glass Co	xiii
Phosphor-Bronze Smelting Co., Ltd	vi
Pond Engineering Co	vi
Queen & Co., James W	xiii
Royce & Marean	xvii
Sawyer-Man Electric Co	xi
Schieren & Co., Chas. A	186
Schoverling, A	xvii
Schuyler Electric Co	xviii
Sessions Foundry Co	xi
Shaw & Co., J. Elliot	xviii
Sigourney Tool Co	xv
Solar Carbon & Mfg. Co	xi
Southern Electrical Supply Co	xv
Standard Electric Supply Co	xxii
Standard Paint Co	xiii
Stanley & Hall	vii & xv
Star Electrix Co	186
Stephenson Co., John	vii
Swift Manufacturing Co., H. E	xi
Tropical American Telephone Co	x
Thomson-Houston Electric Co	viii
United Electric Traction Co	xix
United States Electric Lighting Co	ix
Universal Arc Lamp Co	xviii
Vincent & Co., Charles R	vi
Walker Electric Co	vi
Washburn & Moen Manufacturing Co	xvii
Watson & Stillman	xiii
Western Electric Co	xvii
Weston Electrical Instrument Co	vi
Whipple Co., Fred H	xvi
Williams & Potter	vi
Woodhouse & Rawson	xv
Wyckoff Pipe Co	xviii
Wyckoff, Seamans & Benedict	186

There promises to be a feast of electrical wisdom at the Electric Club dinner this week—Thursday evening.

What better Christmas present for your young friend who is studying electricity than a year's subscription to the ELECTRICAL REVIEW?

The postmaster-general, in his report just published, makes another strong plea for a postal telegraph, and also favors one cent postage for letters, the deficiency from the latter to be made up by extra postage in sample copies of newspapers. Now, hear the newspapers kick.

One of New York's criminals has been respited from death by electricity, on the ground that colored men were excluded from the jury, the condemned man being a negro. Jugigo, the Japanese murderer, will, no doubt, ask for a new trial on the ground that there was none of his race on his jury.

Even in Spain underground wires are now being insisted upon. The telephone company in Madrid has been ordered by the Administration of Posts and Telegraphs to place all its wires underground within six month's time. At present the aerial cables, whi h radiate from the Exchange, completely spoil the appearance of the famous Puerta del Sol, the central square in Madrid. The office is in a corner of the square and is surmounted by a huge cupola, from which tiers of aerial cables stretch in all directions, producing an effect as if the place were overshadowed by a gigantic spider-web.

It is said that when the unfortunate Gaulard was trying some of his experiments with transformers, a noted Parisian scientific writer, protesting against the eulogisms bestowed on the indefatigable investigator, pronounced uncompromisingly that, "electric currents must be continuous or else they could not be at all." Whether electric currents "are" is a question that has not yet been determined, but this very positive oracle must have been somewhat astonished at the rapid growth and development of the alternate current system of electric lighting, and he ought now to be quite convinced that electric currents need not necessarily be continuous in order to do a large amount of useful work.

MUNICIPAL CONTROL OF ELECTRIC LIGHT COMPANIES.

It appears that in Germany municipal control of gas works and electric light stations is in favor. With the exception of Berlin, where the electric light company has just raised its capital from four to five millions of dollars, all the principal cities of Germany are being, or are about to be, supplied with light by their respective municipalities. The city council of Cassel has just bought a central station for $66,000, with a present capacity of 3,000 lamps. Breslau has voted $250,000 for the establishment of a station to commence with 8,000 lamps, and arrangements are to be made for sub-stations to supply ultimately 30,000 lamps. Cologne is shortly to be provided with a municipal station to light the center of the town, 12,000 lamps being calculated for to start with. Düsseldorf has decided on the expenditure of $500,000 for a central station to have a capacity of 20,000 lamps.

In England companies seem to be more popular, as out of 141 "standing orders" granted according to the recent Act of Parliament, only 25 are to municipalities, the remaining 116 being to companies and private firms.

The question of municipal control of electric light stations has been much discussed in this country, quite recently, and is likely to be discussed still further before very long, so it is interesting to see what is being done in the matter across the water.

WANTED.—AN INVENTION.

The latest freak in the way of invention is an electric mouse-trap in which the rodent acts as his own executioner, calmly closing the circuit but then rather suddenly doubling himself into a Gordian knot. This is a clever way of handling the mouse, but then there is such an infinite variety of mechanical traps that the invention will not score a very great hit. There is a bright future, however, for the man who will produce a collapsible skirt to make ladies bid defiance to Mr. Mouse from other points of vantage than the seat of a chair. His firmament will be studded with precious stones of the first magnitude. In suggesting this promising field of thought we remark, in order to save waste of energy, that no draw-string business will serve. There is no time for delay or fumbling when the critical moment arrives. It might perhaps be feasible to close a controlling electric circuit when the skirt is clutched with unusual violence; this would not only save the lady the annoyance of finding herself shutting up like an umbrella at unnecessary times but would render the contrivance absolutely certain to act, at least so far as "pressing the button" is concerned.

THE LIGHT OF THE FUTURE.

The very able and instructive lecture on "The Artificial Light of the Future," delivered by Prof. Nichols before the Electric Club, furnishes electricians with some very rich scientific food, worthy of slow and careful digestion. The lecturer had undoubtedly spent much time in gleaning the data presented. As an illuminating agency, electricity is pre-eminent above all competitors. Inventive genius and indefatigable perseverance have developed an hundred improvements in detail which have elevated it to its present exalted station, yet with all its excellencies, only a small percentage of the energy consumed is returned in useful light, the rest being wasted, so far as human benefits are concerned, in developing waves to which the eye is insensible. The lecturer showed that carbon, which is so admirably qualified to meet all electrical requirements, cannot compare with magnesium and other metallic oxides in proportion of light returned for energy expended. Its high refracting character, conjoined with excellent conductivity, marks it as specially fit for electrical uses; it is unfortunate so many incidents arise in its application to lighting to conspire in reducing its efficiency. In incandescent lamps the molecular disintegration of the filament by the action of the current clouds the bulb and shuts off a considerable portion of the light actually developed. Inventive skill will probably triumph over this difficulty; but aside from this the limit of illuminating power is considerably below that of the metallic oxides. The spectrum of carbon contains a larger proportion of heat rays; this is an inherent difficulty beyond the power of man to remedy. The life of a filament is abbreviated by forcing it to high incandescence, thus precluding us from making most of the steep curve of increasing luminosity. It would seem, then, that in looking forward to any marked increase in lighting power, efforts must be directed toward producing a filament which will not be disintegrated or ruptured by being "forced," or to finding some other material—used alone or combined with carbon—which will develop a spectrum containing a greater relative proportion of light-giving rays. Nature has provided a splendid example of efficiency in the fire-fly and glow-worm; there is a light without heat—so far as the most delicate determinations can show—returning almost 100 per cent. of the energy consumed in sensible light. This humble insect teaches a lesson worth heeding. If we could but understand it and artificially produce the same result it would be the grandest scientific achievement in our history. If the fire-fly's secret ever be discovered, however, it is not likely to prove an ally of the electric lamp. Matteucci carefully investigated the light-giving property of the glow-worm, and it was his opinion, expressed in *Lecons sur les Phènomènes des Corps Vivants*, that the light is due to chemical reaction of oxygen upon the luminous matter in the insect, the oxygen being forced by muscular action into contact with this matter. If the matter could be produced artificially, there would only be needed a simple device for creating an air draft. Perhaps to expect a practical realization of this would be an Utopian dream, and even then the expense of manufacture would likely kill it as a competitor of the electric light. It is a problem of more immediate concern to make the best of a good thing, and we have it in the electric lamp. The researches of Professor Nichols show that there is room for improvement, and the genius of the nineteenth century inventor will inspire the conviction that there is a chance for it.

The long distance telephone line between Vienna and Prague has been in operation for a little over a year, and the success of the line has been so satisfactory that another is to be installed shortly. During the year there have been 38,857 conversations, 16,464 being calls from Prague for Vienna, and 23,393 from Vienna for Prague. The total receipts for the year were close on $20,000. The most unsatisfactory item in the report is that the line was interrupted during 31 days of the year.

CORRESPONDENCE.

OUR BOSTON LETTER.

The Holtzer-Cabot Electric Company, of this city, has just issued to the electrical trade an illustrated pamphlet, giving a full and interesting description of the Eddy automatic electric motors, for which the company named is the selling agent.

Mr. Thomas A. Hurley, representing the wire department of the Empire City Electric Company, New York, was a guest at the Boston Electric Club this (Saturday) evening, and his genial manners won him many friends among the members.

The Warren Thread Works, at Westfield, Mass., has put in operation this week a completely equipped incandescent plant, giving by far a more satisfactory illumination to the various buildings under its control.

The Schuyler Electric Company, Middletown, Conn., has commenced the erection of its new factory building. Steadily increasing business during the past six months has crowded the company's manufacturing facilities to such an extent as to necessitate an immediate enlargement of floor space, additional machinery and the employment of several more skilled workmen.

The New England Printing Telegraph Company has purchased a pole line between Pawtucket, R.I., and the city of Providence, and will establish a branch office in the *Times* building at the first-named place. The company is already doing a very satisfactory business, particularly between this city and New York. Its enterprising management is gradually enlarging the company's service throughout New England.

The B. F. Nichols Belting Company, at Holyoke, Mass., is making two belts for the new electric power house of the Holyoke Electric Light Company. These belts are each double, and are 40 inches wide. They measure in length, respectively, 125 and 150 feet.

The Bird & Sloane Electrical Construction Company, of this city, is comfortably situated in its new quarters in the Hathaway building. This young company starts out with encouraging prospects, having already in hand several large orders to do construction work of various kinds.

The Holyoke Water Power Company, at Holyoke, Mass., will soon have its new electric station ready to furnish electric lights and power on a very large scale. Four water-wheels of 250 horse-power each will be used. These will be interchangeable. There will be boilers to the amount of 1,500 horse-power. Two 400 horse-power engines are to go in; besides these the company has a reserve force of another 350 horse-power engine.

Mr. C. A. Scott, New England manager of the Union Switch and Signal Company, is making a new block signal instrument, which, when finished, will comprise fewer parts and be simpler in construction than others now in use; and it is said that this new instrument will prove equally as serviceable and durable as other devices of the kind.

The Suburban Electric Light & Power Company of this city is extending its business quite rapidly, and has a gang of men at work all the time. It has just closed a contract with the Westinghouse Electric & Manufacturing Company, for a 35 arc light machine and a 150 horse-power generator of 500 volts. The central station at present has a capacity of 2,250 incandescent lights and 70 arcs. The power generator just contracted for is the first one the company intends using. In Roxbury there is said to be a growing demand for electric power for running motors.

The Standard Electric Supply Company of this city has taken the New England Agency for the meritorious switch manufactured by the Star Electrix Company, of Philadelphia. The first named company has also the exclusive control in the New England States for the sale of solar carbons.

Capt. Wm. Brophy, of the Electric Mutual Insurance Company, has returned to his home after a long and arduous business trip. As on previous tours made by the Captain in the interests of his company, he returned to Boston with a large number of risks placed on electric light stations and other electrical properties.

The Bucksport, Me., Electric Company has just finished and shipped an 1,800 cross-arm order for the Hartford Electric Light Company, of Hartford, Conn., and is now filling an order of about 4,000 cross-arms for the Thomson-Houston Electric Company, of Lynn, Mass. W. I. B.

Boston, November 29th.

OUR CHICAGO LETTER.

The ever popular Central Electric Company report a continually increasing demand for improved Candee wire, and in order to meet this demand have stocked their warerooms with a larger quantity than ever. As an instance of their unequaled facilities for doing business in a hurry, they received an order last week for 12,000 pounds of this wire, with underscored orders to "Rush." As a result the wire was delivered at the freight house in less than one hour after the order passed through the office. A good test of this wire, which plainly shows its fine insulation, was made by the Highland Park Electric Light Company, who have adopted Candee wire for their primary circuits. They report that the trial showed an insulation resistance of over one megohm after three days' continuous rain, notwithstanding the fact that the lines are built through alleys, and in a great many cases hang through trees.

Personal.—H. S. Wynkoop, who for some time past has held the position of assistant engineer of the central district of the Edison General Company, has by his own request been transferred to the Pacific district, where his position will be the same. Mr. Wynkoop's many friends will be sorry to hear of his departure, but all combine in congratulating him on his promotion and connection with that able Edison veteran, A. H. Reece, who at present is manager of the Pacific district.—W. W. Griscom, president of the Electro-Dynamic Company, of Philadelphia, Pa., was a visitor in Chicago this week.

On Monday Evening next, E. F. Browne, mining engineer and director of State schools of mines, of Colorado, will read a paper before the Chicago Electric Club entitled "Suggestions from a practical miner on the use of electricity in mines, and an explanation of the proposed underground mining and electrical display of the World's Fair."

Mr. George Cutter, who some time since severed his connection with the Great Western Electric Supply Company, is again in business for himself. He has leased a suite of offices on the third floor of the well-known Rookery Building, from where he will handle a choice line of appliances for electric light and power work, already controling a number of novelties and arranging for pushing others. Mr. Cutter will again drop in with the electrical fraternity equipped with a line of goods which cannot fail to take. This, together with his well-known ability as an electrical expert and consulting electrician, insures him success in this venture.

The Handsome Little Special Circulars gotten up by the Central Electric Company, exhibiting a piece of Okonite wire that has been in use for five years, and which was referred to in these columns in a recent issue, has attracted much attention, and the company have received numerous applications for specimen circulars to frame and be kept as souvenirs.

The Badger Illuminating Company, Milwaukee, Wis., has taken a contract for lighting the above city for the next year, at the rate of $112.50 per lamp.

The Storage Battery Car, which is being run daily on the lines of the North Chicago Street Railway Company, is giving the best of satisfaction. On Sunday last four round trips were made, during two of which a trailer was drawn; 700 fares were collected.

Since the Opening of the Calumet Electric Road, which has given the best of satisfaction, the people of South Chicago have become very enthusiastic over electric railways, and certain capitalists are now talking of building a loop to connect the residence and manufacturing district. The scheme, which was first proposed by R. C. Givins, is to build a road to connect with the cable at Sixty-third street, run south through Eggleston, Auburn, Washington Heights, Morgan Park, Blue Island, Kensington, Pullman, South Chicago and Englewood. The population of this district is about 171,000, and there is no doubt but what rapid transit would be appreciated by the residents of this territory. It is also proposed to operate two cross-lines in connection with the above route. One to run from Auburn Park directly East to South Chicago, the other from Washington Heights due East to Pullman.

H. B. Meech, of Chicago, suggests a novel feature for the World's Fair in the way of an immense glass globe, 20 feet in diameter, revolved rapidly on a tower. Inside the globe are to be 100 incandescent lights; there are to be immense reflectors and the globe is to be filled with reflecting gas. Mr. Meech intends organizing a company to manufacture the lights, which will be used as coast lamps in lighthouse towers.

A Brotherhood of electrical mechanics has been formed by James O'Brien, Harry Wallace, Sam Grimblot and others.

Chicago, Nov. 29th. D. B. D.

The opening of the new underground electric railway in London marks the advent of an era in electric traction. It is the first real encroachment of the electric locomotive upon the domain of the steam locomotive. The ELECTRICAL REVIEW was the only American technical journal which had a reporter on the ground, and our readers will peruse with pleasure the full account of the event sent us by Mr. Ffrench, our London correspondent.

PERSONAL.

Mr. I. H. Farnham, electrician of the New England Telephone and Telegraph Company, Boston, was a visitor in the metropolis last week.

Mr. Clarence E. Stump, for years at the head of the business department of the *Electrical World*, has become one of the proprietors of the *Street Railway Journal*, and after January 1, 1891, will be vice-president and business manager of that successful publishing company. The REVIEW most cordially congratulates Mr. Stump on his deserved advancement, and is pleased to note that this change does not take him out of the electrical field, where for nearly ten years past he has been an industrious and intelligent worker. President J. H. McGraw, of the *Journal* company, now that electricity is entering so largely into street railway work, has greatly strengthened his staff by the addition of Mr. Stump.

Vice-Chancellor Bird filed an opinion, at Trenton, N. J., on November 25th, in the matter of the taxation of the Pennsylvania Telephone Company, in which he decides that a message sent by telephone from one State into another is commerce between the States, and can not be prohibited or regulated by injunction in either State, against persons or corporations engaged in sending such message, because they or it do not pay the taxes assessed against it by such State. The constitutionality of such an assessment may be considered by a Court of Chancery, but the Court of Chancery has not the power to go beyond this and set the assessment aside. This can only be accomplished by a resort to a legal tribunal.

The Light of the Fire-Fly.

BY S. P. LANGLEY AND F. W. VERY.

The authors describe a research on "The Cheapest Form of Light," undertaken with the view of proving by actual measurement that the radiant energy emitted by the fire-fly is practically all utilized in producing luminous effect; and that the invisible heat rays which form so large and wasteful a proportion of the radiation emitted by all ordinary sources of light are, in this case, quite insignificant.

The chief results of the investigation are exhibited in the accompanying curves. In Fig. 1 a photometric comparison between ordinary sunlight and the light of the fire-fly is exhibited by means of two curves, in each of which horizontal distances represent wave lengths, while ordinates denote luminous intensity as measured by a photometer. In the actual experiments, the light of the sun was reduced until the total intensity of the rays tested was equal to that of the light given out by the fire-fly, before analyzing either; and the curves have been so drawn as to have equal areas. It will be noted that while the maximum luminous intensity occurs in each curve in the neighborhood of the yellow green rays, the curve A for sunlight has a much broader base, and shows that the radiation of the sun is less confined to the rays having the most intense luminous effect than is the case with the curve B, which represents the fire-fly light. The four curves shown in Figs. 2, 3, 4 and 5 are energy curves representing, respectively, the light emitted by the gas flame, the electric arc, the sun and the fire-fly. In all these curves the abscissæ, or horizontal distances, represent wave lengths, as in Fig. 1; but the ordinates, instead of representing luminous intensity, denote the energy of the radiation of the particular kind represented by the corresponding abscissæ. The curves are drawn so that the area of each is the same. The limits of the luminous spectrum are denoted by the dotted ordinates, and it is the area of the curve between these limits which represents the proportion of the energy actually used in producing luminous effect. The curve for the fire-fly is seen to lie entirely between these limits, and cannot be represented on the same scale owing to the magnitude of the ordinates; while the curve for the candle flame is such that only about $\frac{1}{15}$ part of its area lies within the limits of the visible spectrum. If the light of the fire-fly could be manufactured on a large scale, it would be far cheaper than any other known form of light; and this does not appear impossible, since vital processes do not seem an essential feature in its production.

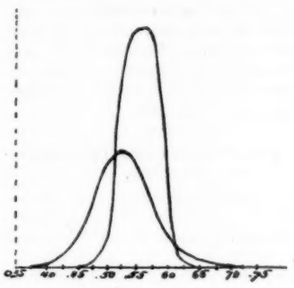


Fig. 1.

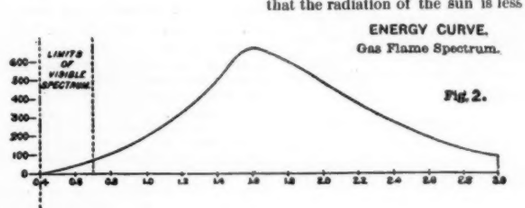


Fig. 2.

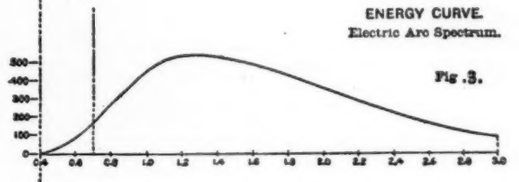


Fig. 3.

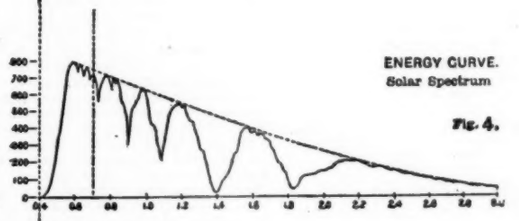


Fig. 4.

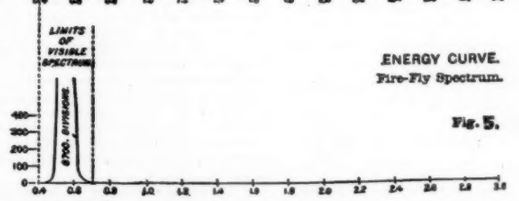


Fig. 5.

Telephonic News

⁂ There are 104 subscribers to the Painesville, Ohio, telephone exchange.

⁂ The city council, of Atlanta, Ga., has passed an ordinance allowing the Southern Bell Telephone Company to build subways and conduits in that city.

⁂ The Central Telephone Company have put up a telephone line from Syracuse, N. Y., to the New York Central Railroad yards, for the railroad company's use.

⁂ It is proposed to establish a network of telephone lines between a large number of towns in Northern Bohemia, and to connect these with the exchange at Prague, Austria.

⁂ The Hudson River Telephone Company is completing its season's work of repairs. Manager Teal, with his force of men, has put in about 300 poles in the past three months.

⁂ The Chattanooga, Tenn., telephone exchange is keeping up with the city's progress. There are now 587 subscribers. Arrangements are being made for putting in a new switchboard.

⁂ The telephone company at Paterson, N. J., has strung a number of neutral wires for the purpose of doing away with the induction from electric light wires which caused the buzzing sound in the telephones of suburban residents; the suburban service has accordingly been greatly improved.

⁂ The Southern New England Telephone Company expects to occupy its new building at Hartford, Conn., by January 1. Before the company moves in the public will be given an opportunity to inspect the new quarters and the many arrangements which have been made to insure a first-class telephone service.

⁂ This is the output of the American Bell Telephone Company for the month ending November 20, 1890:

	1890.	1889.	Inc.	Dec.
Gross output.....	5,316	3,763	1,555	
Returned.....	2,926	2,929	.....	3
Net.....	2,392	834	1,558	
Since Dec. 21.	1889-90.	1888-89.	Inc.	Dec.
Gross.....	59,105	52,157	6,948	
Returned..... ...	25,241	22,827	2,414	
Net.....	33,864	29,330	4,534	

⁂ The officials of the Bell Telephone Company emphatically deny the report that the company is contemplating a departure in its policy of renting private telephones. The only way that they can account for the story is upon the supposition that a recent discussion by the directors upon the policy that might be adopted when the basic telephone patents expired, in 1893 and 1894, may have given rise to it.

⁂ The Sunset Telephone and Telegraph Company now has over 600 telephones on its Seattle, Wash., circuit. Connection has also been made with Tacoma and all way stations. While a year ago only four operators were employed—three day and one night—there are now eight operators, seven day and one night. W. P. Armstrong, manager of the Seattle exchange, has been promoted to the management of the San Francisco office, and is succeeded there by H. A. Clark, who has had charge of the switchboard at Victoria, B. C.

⁂ In the office of the water board at Lowell, Mass., is an old Blake transmitter. A card attached to it tells this story: "Blake transmitter No. 277, property of the American Bell Telephone Company, and the first one used in Lowell, Jan. 1st, 1879. This instrument transmitted the first sermon by telephone from the Paige Street Freewill Baptist Church, Feb. 16th, 1879, to a large number of telephone subscribers of the Lowell system and parties in Foxboro, 50 miles, and Boston *via* Foxboro, a distance of 80 miles. Text: 'Can ye not discern the signs of the times?' Sermon by Rev. E. W. Porter. Every word spoken, as well as the organ and singing, was distinctly heard."

Lecture by Mr. Carty.

Mr. John J. Carty, electrician of the Metropolitan Telephone and Telegraph Company, of this city, delivered a lecture on "Telephony" before the Young Men's Institute, of New York, on November 25th, starting with the origin of sound. Mr. Carty led up in a lucid and logical manner to the "lovers' telephone," the pulsion or mechanical telephone, the Bell instrument, and finished by describing the long distance telephone as used to-day. The lecturer also interspersed a little physiology, showing by interesting diagrams the human organs of sound production and the action of the various parts of the ear in receiving and transmitting to the brain the two forms of sound—music and noise. The lecture was thoroughly illustrated by well drawn diagrams, and was listened to with interest and attention by a good sized audience.

A Quick Transfer of a Telephone Exchange.

The following interesting account of the transfer of a telephone exchange, at Cincinnati, is taken from the *Times-Star*, of that city:

When, four years ago, the Central Telephone Exchange and four other exchanges moved to Third and Walnut, to make the final transfer required just three minutes and eight and a half seconds. To make a similar transfer in a neighboring city had required four days of continuous interruptions of the business of subscribers. Here the interruption was but a little more than three minutes. That was an average of one minute interruption to each 600 subscribers, the number cut into the central exchange amounting to a little over 1,800. Saturday, the transfer from the old Broadway exchange, the exchange that the residents of Walnut Hills, Mt. Auburn, Avondale and the business houses in the vicinity of Court and Broadway had used, to the new exchange on McMillan street, required but 26 seconds. That 26 seconds represented all the time of interruptions to business of the subscribers whose lines run into the new exchange, and there are just 497 of them, together with 129 trunk lines.

In the old Broadway exchange there were 704 subscribers' lines and 129 trunk lines, but 207 of the subscribers' lines were transferred to the central exchange.

The new exchange is located in a new pressed brick building, erected on McMillan street, west of Gilbert avenue, by the telephone company, for the express purpose of an exchange. The business of getting this building ready and of changing the old steel wires for copper, has been going on all Summer under the careful supervision of Mr. W. H. Robinson, the company's electrician. That the work was well done was fully attested by the unexampled quickness of the transfer Saturday. The new quarters on McMillan street are built with especial reference to expediting the business of all the subscribers who live on Walnut Hills, Mt. Auburn and in Avondale. There is no modern contrivance in electricity, so far as it applies to the telephone business, that has not been adopted in the new exchange. The expense involved in making the change from the old to the new represents not less than $50,000. The switchboard, made of solid mahogany, is of Chicago manufacture, and is almost a duplicate of the board used in the central exchange.

The telephone transfer on Saturday, which breaks the record of all other transfers, was made in the presence of General Manager Stone, several of the telephone directors and several friends of the company.

A Telegraph Pole as a Storehouse.

While walking through the Museum of Natural History, at Central Park, recently, I saw in one of the glass cases part of a cedar telegraph pole, thickly perforated with holes. On inquiry, I learned that these holes had been dug in the pole by the California woodpecker, for the purpose of storing acorns for its Winter food. Some of the acorns may still be seen in the pole, although most of them had been extracted before it was cut down.

It has long been known that these busy workers store acorns in the bark of standing trees, but the use of a telegraph pole for this purpose is an entirely new selection, and while, perhaps, the feathered gentry find it a very convenient storehouse, their method of taking possession is decidedly damaging to the telegraph pole.—*St. Nicholas for December.*

What is "Earth"?

ABSTRACT OF A PAPER BY SYDNEY F. WALKER.

Probably no phenomena connected with electrical engineering require such careful study, and such a thorough mastery, as those we know under the generic name of "earth"; yet probably about none are there so many hazy ideas entertained by those with whom the term "earth" is an expression as commonly used as any phrase in our language.

In the writer's opinion, a true conception of what really constitutes "earth" will clear up the whole of the mystery attached to the proper method of protecting not only buildings, but also telephonic and electric lighting plants from the destructive action of lightning. Probably the most correct sentence uttered by Dr. Oliver Lodge, in his crusade against the existing forms of lightning conductors, was that in which he said that "earth" was a geological question. For lightning currents the formation of the strata, into which a conductor may lead them, must have a very great influence upon their ultimate behavior.

When using the electrophorus, it will be remembered, "earth" is the finger of the operator. When charging a Leyden jar or other electrical condensor, one coating is always put to "earth" by being connected to or allowed to rest directly on the table which supports it. In both these cases the earth connection is merely, as before, a connection to the other side of the inductive circuit. With lightning conductors, "earth" assumes most varied forms, from a tombstone into which the end of the conductor is leaded or a bottle resting on the stone, in which the end of the conductor is allowed to repose; to a large copper plate buried in moist ground, or in a pit into which a load of coke has been tipped.

Perhaps the most instructive lessons in this matter come from the use of "earth" as a return conductor in ordinary electrical engineering work. For small telegraph or telephone currents, for instance, each of comparatively high resistance, may be used, where only a single wire is joined, the same pair of earth connections; but if a number of wires all connected to the same earth, at any particular station, unless earth there is remarkably good, the path for the current through earth back to the battery from which it started, being only one of many paths open to it, may not offer so much less resistance than that of the other paths through other wires to other connections, and thence to the original starting point, as to preclude portions of the incoming current from finding their way into the other wires, and working any apparatus that will respond to their feeble force. In fact, much of the cross-talk between telephone lines, in telephone lines using "earth" returns, is due to this cause, and even indicator disks will often drop when they are not intended to, through the return split from some incoming current not properly led off by "earth."

Water is not always the only conductor available for earth. Coal, for instance, appears to act as a conductor of high specific resistance, and it is probable that veins or pockets of metalliferous ore would do the same, though the writer believes no measurements have been made of any of them. Again, it is very doubtful if a really efficient "earth" can be obtained anywhere for a large electric lighting or power current, unless the bed of a large stream be near both points between which the current is to pass. The "earth," so called, which is formed by the skin of the ship, where the single-wire system of wiring for electric lighting on board ship is used, is not proper "earth." It is merely a large metallic conductor available at all points, supported, if you will, by the water in which the ship floats.

Again, with dynamo machines of high tension, it is usual to express the fact that the dynamo is not perfectly insulated by saying it is making "earth," and this is quite correct. Some portion of the current generated is actually passing, by way of the frame of the machine, to the moisture in the flooring and other adjacent objects, and the unfortunate individual who receives a severe shock by accidental contact with some other metallic portion of the circuit, owes the shock to the fact that the dynamo itself is making "earth."

Once the wire leading to an electrical apparatus is struck by a current—either directly from, or induced by, a thundercloud—and there is any passage to earth, as there invariably is, through the apparatus, there is only one way in which the apparatus can be protected by an earth connection, viz., by making that connection in such a manner, and part of such a circuit, that the E. M. F. of the destructive current outside the apparatus is thereby reduced below that which would cause a dangerous current to pass through the coils of the apparatus it is designed to protect. It must be remembered that, both in the case of the man standing on the ground touching a bared portion of a high tension electric light plant, and in the case of a telegraph or telephone instrument which it is desired to protect from lightning, the man and the coils of the instrument form derived circuits to earth, parallel with the protecting path where one exists. This same reasoning applies to the instances of side flash, which have been unhappily so frequent, and which have led Dr. Lodge to the conclusion that "earth," if not actually bad for a lightning conductor, is at best a doubtful blessing. The side flashes, it will be noticed, have invariably been to gas brackets, or to some conductor connected directly or indirectly to earth; and the flash itself has been due to the fact that an E. M. F. existed at the point of the lightning conductor nearest to the bracket or other object to which it flashed between it and the "earth" to which a path led by way of the object, and that this E. M. F. was of sufficient magnitude to drive a current in the form of a spark across the intervening air space, and through the object to "earth." The problem, after all, of protecting buildings from lightning, or at least an important part of it, is how to expend the energy of the thundercloud so that no dangerous E. M. F. may exist in a position to throw sparks to other conductors leading to earth, in which, as in gas pipes, the current may do serious damage. This would lead to the recommendation that all gas and water pipes, and all metallic conductors leading to earth, directly or indirectly, should be connected to the main conductor, were it not for the fact that this plan might defeat its own object by rendering it certain that whenever a conductor was struck, a portion of the lightning current would go by each of the paths so provided, and that in its passage any such portion might meet with some local resistance, such as a white leaded gas joint, that would cause it to generate sufficient heat to ignite the gas, or that a minute air space might be in its path, not of sufficient size to bar its progress, but sufficient to cause a spark with its attendant troubles.

In the writer's opinion, much of the damage which is done by lightning is due to the intense heat generated by the spark or flash, which often suddenly converts the moisture held in bricks or stones into steam. The sudden expansion of a body previously held in the pores of a coping stone, for instance, into a vapor 1,700 times its original volume, will account for a good many of the terrible accidents recorded. The whole bearing of "earth" upon the problem of the safe discharge of a thundercloud, and of the best method of protecting buildings, etc., from the destructive effects of lightning, the writer hopes shortly to discuss in another article, as the subject is too wide to be included in the present one.

The Primordial Germ of the Telephone.

A correspondent of the London *Electrician* has dug up an article published in a newspaper at Frankfort, in 1854, which robs Philip Reis of the glory claimed for him by Prof. Sylvanus Thompson as the inventor of the telephone. As evidence of prophetic realization of the possibilities inherent in the subtle electric current it is an interesting scrap of history, but so far as any anticipation of the practical reality of transmitting speech is concerned it is worthless. It must be placed in the same category as Reis' apparatus—a device for rapidly *making* and *breaking* an electric current. Such apparatus while abundantly capable of transmitting musical notes involving such air-vibrations only as are necessary to pitch, fails to transmit *quality* which is inherently necessary in speech. This is what *The Dedas Kalia* is said to have printed on September 28, 1854:

ELECTRICAL TELEPHONY.

The number of miracles with which electricity has astonished us lately is said to have been increased by one which would not only cause a revolution in electrical telegraphy, but would add considerably to its utility. The invention in question is nothing less than the electrical transmission of the *"spoken word."* The idea was conceived by an educated and modest young man named Charles Bourseul (now living in Paris), who was a private in the African army in 1848-where he brought himself under the notic-of the Governor-General by a course of math, ematical lectures which he gave to his come rades in the garrison of Algiers. Possibly Bourseul's scheme, of the practicability of which he is perfectly convinced, may be one of those which learned men will afterwards declare very simple, and which, if troubled about, would have been brought out much sooner. The principle of electro-telegraphy, as is well known, is the following: An electric current passing through a metal wire surrounding a piece of soft iron, transforms the latter into a magnet. The magnetic properties of the iron vanish when the electric current is discontinued. This magnet, called the electro-magnet, can, therefore, alternately attract or repel a movable plate which, by its forward and backward movements, produces the conventional signals used in telegraphy. It is further known that all sounds are transmitted to the ear through

the air vibrating; and that, therefore, sounds are virtually vibrations of the air, and that the infinite variety of sounds is solely dependent on the rapidity and strength of these vibrations. If it were possible to construct a metal plate sufficiently sensitive and flexible to admit of the reproduction of the vibration of sounds (like the air), and if this plate could be connected with an electric current in such a manner as to alternately interrupt and continue it according to the vibrations of the air to which it would be exposed, it would be equally possible to electrically affect a similar metal plate so as to repeat exactly and simultaneously the vibrations of the first plate. This would create the impression as if the speaker had spoken in immediate vicinity of the second plate, or, if put differently, the ear would be affected in a similar way as if it had received the sounds through the first metal plate. Electrical telegraphy, which was once academically declared to be almost an absurdity, is now almost universally established; and if we investigate this new idea of the young scientist on the principles of physics, we find that not only no objection could be raised against the soundness of his theory, but that its practicability is more probable than that of electrical telegraphy was only a short time ago. If the theory should prove a success, electrical telegraphy will attain a position of general usefulness. No special knowledge or apparatus will be required, except a galvanic battery, two suspended plates and a metal wire. Without any other preparation one person will have to speak into one of the plates, while the other person places the second plate close to his ear, thus enabling them to converse as if in private.

The youthful inventor is confident of the success of his invention, and challenges scientists to prove the impracticability of his theory on scientific grounds. In the meantime the invention fully deserves the attention which will, no doubt, be bestowed on it.

Electricity in Switzerland.

Dr. A. Denzler recently gave, in the *Schweizerische Bauzeitung*, statistics as to the position of electric lighting and of electric transmission of power in Switzerland at the close of the past year. There were altogether 351 electric light installations, with 408 dynamos, having a total capacity of 5,150 kilowatts. Current was supplied to 51,155 incandescent lamps of various candle-powers, and to 845 arc lamps. Of these 351 installations, 347 employ continuous currents. The four using alternating currents are the central stations at Brunnen, Lucerne and Vevey-Montreux, and a small private installation at Wald. The driving power consists in 177 cases (50.4 per cent.) of hydraulic motors, in 138 cases (39.3 per cent.) of steam engines, in 32 cases (9.1 per cent.) of gas engines, and in four cases (1.2 per cent.) of electromotors. There are employed 41 batteries of accumulators, mainly of Swiss make, in connection with the direct lighting. As regards transmission of power, there were 24 installations, the power transmitted varying from two horse-power to 280 horse-power, and the distance between the generating and receiving stations ranging from one-third of a mile to six miles. The total number of dynamos and motors thus employed was 75, representing an effective output of 1,714 kilowatts. These figures include the electric tramway at Vevey-Montreux and the electrically-driven cable railway on the Bürgenstock. There are also, in addition to the foregoing, many dynamos employed for electro-chemical, galvanizing and laboratory purposes. It is impossible to exactly state the figures regarding these, but they are estimated at 45 machines, with a total output of 170 kilowatts.

A False Alarm.

When the fireman of the Metropolitan Opera House arrived there one afternoon, recently, he walked at once to the big board covered with electric buttons which announce and give signals and direct the gasman and the curtain raisers and pretty much everything else.

He has a button all to himself which announces his arrival at the theatre. He touched the wrong button—the fire signal—and in a second saw what he had done, but it was too late then.

The house inside was packed with people at the benefit for the Roman Catholic Orphan Asylum, and, as he very well knew, the engines were already on their way, bringing panic and terror with the clatter of their bells.

"Got out of here," he yelled to the scene shifters. "Get out of here and stop them engines. Each one of youse take a different street, and tell 'em not to come and not to ring the bells. Run!"

The scene shifters threw themselves before the engines, waving their hands and calling on the drivers to stop.

The drivers in every instance recognized what was wanted and stopped their horses, and the big audience did not know until they read the *Evening Sun* that night how near they were to having a very serious scare.—*Evening Sun.*

About Lightning Strokes.

A statistical investigation of lightning strokes in central Germany, covering a period of 26 years, has been recently carried out by Herr Kastner. The number of cases has increased about 129 per cent.; in 1889, it amounted to 1,145. The author distinguishes four thunderstorm paths. The starting points of all these are in hills, and in their course the woodless districts and flat country, river valleys and low meadow ground about lakes seem specially liable, while the wooded and hilly parts generally escape. The hottest months (June and especially July) and the hottest hours of the day, or those immediately following them (3 to 4 P. M.), show the most lightning strokes.

Royal Society.

The following is the list of names recommended by the president and council of the British Royal Society for election into the council for the year 1891, at the anniversary meeting on December 1st: President, Sir William Thomson; treasurer, Dr. J. Evans; secretaries, Prof. Foster and Lord Rayleigh; foreign secretary, Dr. Geikie; other members of the council, Prof. Ayrton, Mr. W. H. M. Christie, Prof. Boyd Dawkins, Dr. Glaisher, Dr. Müller, Prof. Alfred Newton, Sir. W. Roberts, Mr. Roberts-Austen, Prof. E. Schäfer, Sir George Stokes, Lieut-General Strachey, Prof. Joseph Thomson, Prof. Thorpe, Sir William Turner, Prof. Vines and General Walker.

A Christmas Holiday Tour.

A TRIP TO WASHINGTON, D. C., UNDER PENNSYLVANIA RAILROAD COMPANY'S PERSONALLY-CONDUCTED SYSTEM.

The bustle and excitement which Christmas week carries with it makes many feel the need, as the end of the year draws nigh, for some little, and needs be inexpensive, recreation. For several years past the Pennsylvania Railroad Company has run from New York, Brooklyn and Jersey City a series of Christmas holiday pleasure tours to the national capitol, Washington, at this season of the year, living in an atmosphere of gayety, and also at a time when sight-seeing can be enjoyed thoroughly. This company now announces that from New York, Monday, December 29th, 1890, a special train of Eastlake coaches will leave for Washington, stopping at Philadelphia for dinner going, and supper returning. Tourists will remain in Washington, where special features for their entertainment have been provided, until December 31st. The rate for the round trip, including railroad fare, hotel accommodations, and all necessary expenses, is but $12.50, covering this delightful recreative tour of three days. A tourist agent, a chaperon, and a special baggage-master will accompany the party, and all those desiring detail information, with a descriptive itinerary, should apply to W. W. Lord, Jr., tourist agent, 849 Broadway, New York.

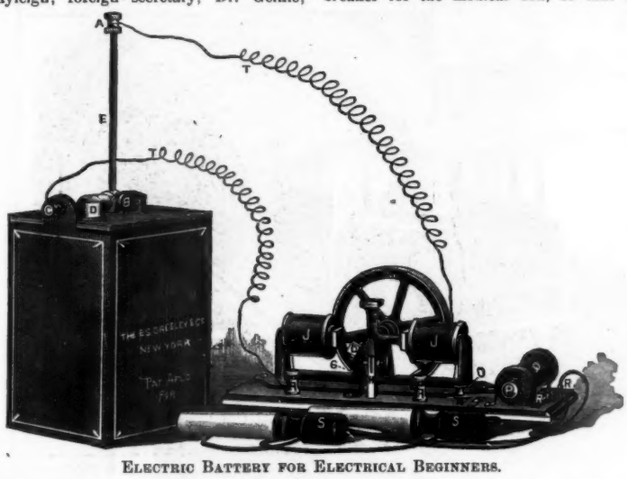
The new line of the Western Union Telegraph Company, which is being built between Easton and Mauch Chunk, Pa., has been completed as far as Redington.

For Amateur Electricians.

While The E. S. Greeley & Company are looking after the higher branches in the electrical trade, our illustration gives evidence of the fact that they also are not neglecting the entertainment of the little folks and amateurs in the Christmas season. The cut in question illustrates a very happy combination of battery, motor and medical coil. The battery is built under the Nowotny patents, and consists of a square cell of carbon, which forms one element of the battery and at the same time is the containing vessel for the fluid. Treatment of the carbon on the outside of the shell prevents all leakage. The zinc element is in the form of two fingers, which ride upon a central shaft after the method of the Grenet battery, making a plunge battery, and all that is necessary to be done to put the battery in action is to lower the zincs, and to throw the battery out of action, to raise the zincs and fasten them in the raised position by means of the small clutch or screw provided for that purpose.

The ingenuity of the device is shown in the feature of the circuit breaker or commutator of the motor acting as the circuit breaker for the medical coil, so that no vibrator whatever is required upon the coil, and the coil may be either kept in action or thrown out, as desired.

It is claimed that the battery has capacity to run the motor and coil for a period of about 12 hours at a single charging. The active solution employed being bichromate of potash, is readily procurable at all electrical establishments and druggists. The outfit has been christened the "Holiday Motor and Coil Electric Outfit."



ELECTRIC BATTERY FOR ELECTRICAL BEGINNERS.

The Westinghouse Snow Plow.

A new snow plow, to be utilized upon electric street railways, is now being manufactured by the Westinghouse Electric Manufacturing Company, in connection with the Westinghouse system of electric street railway motors.

The Westinghouse snow plow consists of an ordinary car truck equipped with two motors, one of which performs the propulsion of the car, while the other is used to revolve two sets of shovels. These shovels are encased in a circular box, which is so attached to the front of the truck and so designed that it glides closely over the track and the rails of the railway line. As the snow plow moves along all the snow on the rails is picked up by the circular box. The revolving of the shovels brings the snow to the top of the case, where it is emitted through a spout. This spout can be adjusted with the opening turned towards either side of the car.

The plow has a very neat appearance, it is made of the best material—in fact, mechanically as well as electrically, its construction is equal to anything the Westinghouse Electric and Manufacturing Company ever brought into the market.

The electrical committee of the Philadelphia Council met last week and approved an ordinance granting permission to the Western Union Telegraph Company to lay conduits between Thirteenth and Fifteenth streets and Filbert street and South Penn square, on condition that the overhead wires and poles be removed.

TELEGRAPHIC

.... A lot of poles, 80 feet long and eight inches in diameter, were shipped from Three Rivers, Mich., a few days ago.

.... Captain Simpson, depot quartermaster at Omaha, Neb., is engaged in rebuilding the telegraph line from Rushville to Pine Ridge agency. The Indian troubles have made this necessary.

.... The Plattsburgh, N. Y., board of trustees have passed a resolution requiring the telephone, telegraph and electric light companies to paint all poles owned by them within the corporation inside of ten days, or the same will be removed by the trustees.

.... The reconstructed and enlarged Western Union Telegraph Company's new building, at Broadway and Dey street, New York, will have an elevation of 11 stories and be 167 feet from curb to roof. It will embrace Nos. 8, 10 and 12 Dey street and cost, estimated, $150,000.

.... The Western Union Telegraph Company is building a new Wheatstone circuit between San Francisco and Chicago direct, by the way of Albuquerque, N. M., and known as the Santa Fe wire, by which San Francisco and other Pacific coast points will be placed in direct communication with Chicago.

.... The preparations for laying a telegraph cable from Australia to British Columbia, across the Pacific Ocean, are advancing in an orderly way, and there are prospects of success in finding a suitable bed for the cable. The work of laying the new cable between Guatemala and United States is making fair progress, and there is good hope that we shall soon have telegraphic communication with several countries of Central America.

.... The annual meeting of the American District Telegraph Company, of Brooklyn, was held on November 17. The following trustees were elected: H. D. Polhemus, S. H. Herriman, Felix Campbell, J. F. Pierce, M. N. Packard, David Barnett, Charles H. Wheeler, W. M. Van Anden, A. B. Thorn, E. Spicer, S. Richards, T. J. Powell, H. H. Wheeler. The newly-elected board organized with the following result: President, Hassan H. Wheeler; vice-president, David Barnett; secretary and treasurer, Tunis J. Powell; executive committee, H. D. Polhemus, C. H. Wheeler, M. N. Packard.

.... Information has just been received in Ottawa, Can., of the second season's work of H. M. S. "Egeria," a man-of-war deputed to make an examination of the bed of the Pacific Ocean, with the object of discovering the best route for a cable from Canada to Australia. Last year was spent at Auckland, New Zealand, and the Fiji group. The deepest sounding obtained south of the equator was 4,530 fathoms. Unfortunately, the nature of the bottom at this great depth was lost, through the wire parting when heaving in. Three islands of the Phœnix group were surveyed in sufficient detail to ascertain their suitability for a telegraph cable. The vessel is now further engaged with the survey of the work, and the British flag has been hoisted on all the islands visited in the Pacific which are not under the protection of any other power.

.... The British Minister to the Argentine Republic and Paraguay, states that since visiting the latter country, in 1886, he notices a very considerable advance in the progress of the country in every way. Still, he adds, "that a want very largely felt at Asuncion, is regular telegraphic communication with Monte Video or Buenos Ayres, and so with the world in general. At present (August, 1890), as in 1886, the telegraph line stops on the frontier of the Argentine province of Corrientes, the missing link between which and the line in Paraguay being furnished by a person of apparently somewhat lethargic habit, whose movements on the Parana in a canoe seem rather to depend on the rule of avoirdupois, as applied to the bundle of telegrams whereof he is bearer, than to the urgency or value of the messages themselves. Doubtless, however, an improvement will be apparent in this direction ere long."

* * It is said that the Pittsburgh Traction Company will reduce fares from five to three cents within a few weeks.

* * The selectmen of Camden, Me., have revoked the permission to lay tracks for an electric railroad in the streets of Camden.

* * The Rosedale, Ky., and Cincinnati Electric road has secured a one-cent-per-passenger toll rate over the C. & O. bridge.

* * The Sheriff of Philadelphia has received attachments aggregating $5,462 against the New York Electrical Manufacturing Company.

* * Both houses of the Seattle, Wash., city council agreed to accept the offer of free passes to all members made by the Seattle Electric Car Line Company.

* * The Thomson-Houston Electric Company has sold out its interest in the Newport, R. I., Street Railway Company, to a syndicate composed mostly of Newporters.

* * Mayor Todd, of Owosso, Mich., has vetoed the street railway ordinance for an electric road between Owosso and Corunna, on the ground that the Lansing Company have a prior right.

* * The selectmen of Whitman, Mass., have granted a franchise to the Hatherly Street Railway Company, of Rockland, for a right to construct an electric road from the Abington line to Auburnville in that place.

* * The Richmond, Va., Railway and Electric Company, which some time ago absorbed two street car and three electric light and power companies, has filed a mortgage deed for $2,000,000 to secure the Atlantic Trust Company, of New York.

* * C. H. Bayley, of Boston, has patented an illuminated street car sign for use in designating the route of the car after night. Incandescent lamps supply the light where the signs are used on electric cars, and oil lamps where they are used on horse cars.

* * Work on the electric road at Whitinsville, Mass., is progressing rapidly, and it will soon be in operation. Another week of good weather will take it out of the highway. A large freight house has been built in the west yard of the Whitin Machine Works.

* * Dr. E. C. Kilbourne has moved into his new residence at Green Lake, near Seattle, Wash. It is said to be a perfect exhibition of the uses of electricity. It has a dynamo to supply light, electric bells and burglar alarms, motors to run sewing machines, the pump and for other purposes, and electric heaters in every room.

* * Lowell, Mass., is going to fall into line with the other progressive cities of the country and abandon horse for electric power. The Lowell Horse Railroad Company and the Lowell & Dracut Street Railway Company, are the roads proposing to make the change and intend to jointly spend about $475,000 in putting in the new system. The Board of Alderman last week gave both companies the permits they desire and they will commence work as soon as possible.

* * The railway department of the Thomson-Houston Electric Company, at Chicago, report the sale of electrical apparatus and equipment for 15 double motor cars, including generators, to the San Antonio Street Railway Company, San Antonio, Tex. The present line embraces about 10 miles of track, and under their recent contract with the Thomson-Houston Company they will equip about 10 miles of additional track. The Chicago department also reports a very brisk business in the introduction of their perfected snow sweepers, having sold seven of them to their railway companies in the West during the last few weeks.

OUR LONDON LETTER.

OPENING OF THE UNDERGROUND ELECTRIC RAILWAY DESCRIBED BY OUR OWN CORRESPONDENT ON THE GROUND.—GENERAL ELECTRICAL NEWS OF EUROPE.

The City and South London Railway.—This enterprise, one of the most remarkable engineering feats ever brought to a success, was formally opened on the 4th inst., by His Royal Highness, the Prince of Wales. At 12 o'clock, the chairman of the company, Mr. C. G. Mott, received the Prince and his eldest son, the Duke of Clarence and Avondale, at the city terminus in King William street. Descending the hydraulic lift, the Prince of Wales was handed a gold key with which he proceeded to turn on a small switch giving the signal for current into the conducting mains. Among those who witnessed the act were the Lord Chancellor, the Lord Mayor and Sheriffs, the engineer, Mr. J. H. Greathead; the secretary, Mr. H. H. Smith; the manager, Mr. T. C. Jenkin; the consulting electrician, Mr. C. E. Spagnoletti; General Hutchinson and Mayor Cardew of the Board of Trade, and the consulting engineer, Sir John Fowler.

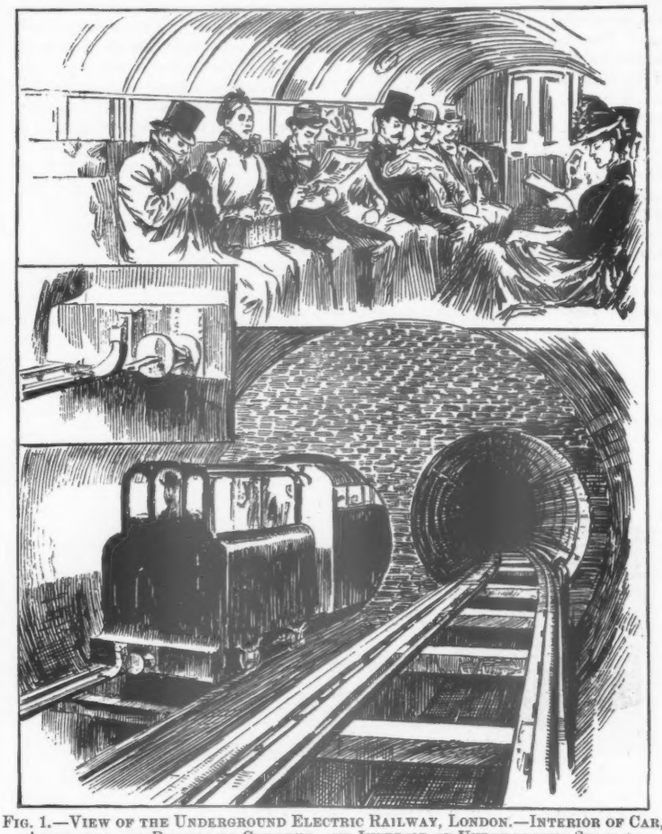


FIG. 1.—VIEW OF THE UNDERGROUND ELECTRIC RAILWAY, LONDON.—INTERIOR OF CAR, APPLIANCE FOR PICKING UP CURRENT, AND INTERIOR OF UNDERGROUND SECTION.

The electric locomotives and carriages having been examined, the Prince of Wales and about 40 gentlemen entered the two saloon cars which formed the train. Sir W. Mather, M. P., and Dr. Edward Hopkinson were in charge of the engine, which was driven by Mr. G. A. Grindle and Dr. John Hopkinson. No stoppage was made either at the Borough, Elephant and Castle or Kensington stations, and in nine minutes the Oval station, a distance of two and a half miles, was reached. The whole party alighted here and examined the various equipments, afterwards proceeding on to the Southwest terminus at Stockwell. Luncheon was here served in a highly decorated Indian pavilion, and nearly 300 guests sat down. The president was, of course, Mr. C. G. Mott, who had on his right the Prince of Wales, and on his left the Duke of Clarence and Avondale. Besides those before mentioned there were present, Sir Frederick Abel, Sir F. Bramwell, Sir. B. Baker, Sir Henry Roscoe, Sir Douglas Galton, Sir E. Reed, M. P., Sir John Monckton, Sir Henry Tyler, Sir David Solomons, Dr. Silvanus P. Thompson, etc.

The toast "Success to the City and South London Railway" was very happily proposed by His Royal Highness, and the chairman in replying stated the design was that of Mr. Greathead, who had personally superintended the carrying out, and was assisted by the company's consulting engineers, Sir John Fowler and Sir Benjamin Baker. It had first been intended to use the endless cable system, but the directors subsequently decided to adopt electricity on method suggested by Messrs. Mather and Platt, and worked out by Dr. Edward Hopkinson, in conjunction with his brother, Dr. John Hopkinson.

Messrs. Mather and Platt guarantee that for the first two years the traction expense shall not exceed 8½*d.* per train mile, and when one remembers that on the Metropolitan Railway the cost is 16*d.* per mile with a train capacity of 450 passengers, the greater economy of the use of electrical power is very forcibly brought before the mind. The greater safety to passengers is another advantage which is sure of hearty appreciation. On the system in use on the City and South London Railway, in the event of a train breaking down the current is at once cut off from the section, and it is impossible for one train to be run into by another following.

The whole length of the subway is 3¼ miles, and two circular iron tunnels 10 feet in diameter are used, driven about 60 feet below the surface, through the London clay, at an approximate cost of £220,000 per mile.

The boilers were supplied by Messrs. John Fowler & Company, of Leeds, as well as engines, and the framework of the electrical locomotives have been constructed by Messrs. Beyer, Peacock & Company.

The working conductor is of channel steel carried on glass insulators, the arrangement being precisely similar to that used by Dr. Edward Hopkinson on the Beysbrook and Newry line.

Messrs. Mather and Platt have supplied the 14 ten-ton electric locomotives and each is capable of developing 100 effective horse-power and of running to 25 or 26 miles per hour. A train consists of an electric locomotive and three passenger carriages, 32 feet in length from end to end of the foot board. The interior of each carriage, which is divided by a door in the center, contains seating accommodation for 34 persons.

In the event of any failure of the depot engine or any other cause bringing the train to a standstill, a passage has been provided in the tunnel clear of the rails and two feet wide and there could be no greater distance to traverse than three-eighths of a mile.

The lifts at each station are semi-circular in form and carry 50 persons at a time. No tickets will be issued, but on entering from roadway the passenger will pay his money and go through a turnstile, either using the lifts or the stairs at option. The charge, either for the whole distance or a portion, will be two pence, and there is to be no distinction of classes, the carriages all being comfortably cushioned and fitted. The trains, when the line is in full working order, will follow one another at intervals of three minutes. Gas is used for lighting the stations. For the water supply of the steam boilers, there are two large tanks of 12,000 and 25,000 gallons, respectively, which will be kept in reserve, water being taken from the water company's mains.

Everything possible has been done for safety and comfort to passengers, and it is hoped that so grand a scheme carried to so successful a finish, may justify the labor expended on it and, proving a rich boon to the inhabitants of South London, may richly repay the trouble, work and outlay of its originators.

Electricity in the French Navy.—The French Minister of Marine has decided that every military post shall send to Paris two foremen and two working electricians to study the various systems of electric lighting. Lectures upon the theory and use of electricity and its employment for naval purposes, will begin at the Paris Observatory on the 11th inst., and will be continued for four months.

Frankfort-on-Main Exhibition.—A congress will be held in connection with this exhibition, and Herr Werner Siemens is to be asked to take the presidential chair. Herr Von Stephen, of Berlin, has become chairman of the organizing committee of the exhibition.

Electrical Securities.—The financial crisis consequent on the discovery of the position of the affairs of Messrs. Baring Brothers & Company has necessarily affected these shares as well as all others, but it is a matter for surprise that the decline has not been of a more serious character. The prompt action of the Bank of England has prevented what would have been a world-wide disaster.

CHARLES FFRENCH,

London, Nov. 14, 1890.

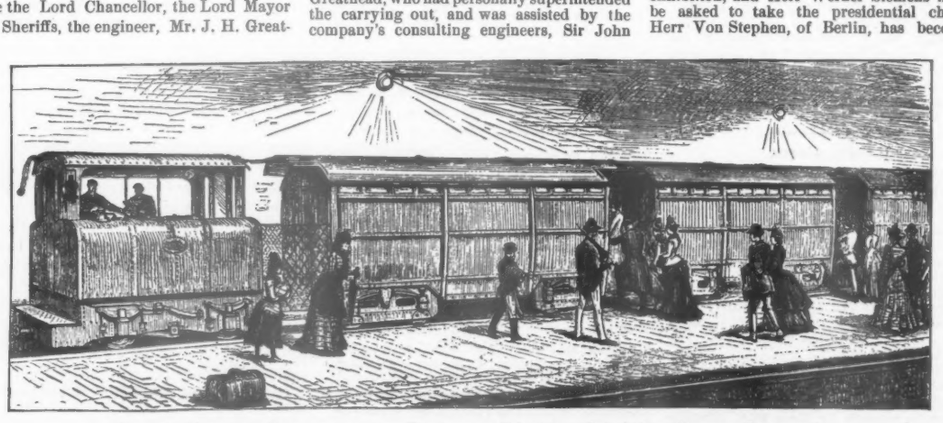


FIG. 2.—ELECTRIC LOCOMOTIVE AND PASSENGER COACHES.—SEE "OUR LONDON LETTER."

Electric Heater for Cars.

The accompanying illustrations (Figs. 1 and 2) show a system of electric street car heating now being placed on the market by Mr. C. B. Hanna, general agent of the Carpenter-Nevins Heating Company.

The heater, as shown in Fig. 1, consists of a narrow strip, or ribbon, of asbestos enclosed in sheet iron, about three inches in width and about one-quarter inch in thickness, which is intended to extend from one end of the car to the other, under the seats, on both sides, midway between the seat and the car flooring, and protected from the person or clothing of the passenger by a wire screen. It is enclosed on all sides except the face in a copper radiator or deflector in order to divert the heat into the proper channel and to protect against loss. A second strip of iron of the same dimensions is attached to the first strip by a single row of small bolts extending from end to end, thus serving the purpose of a compressing plate and, at the same time, forming the other side of the heater. The resistance wires are imbedded in asbestos, and the compression plates are bound firmly together by means of the small bolts before mentioned, and are located between the two strips of iron. Three or more resistances of reflex or zigzag form are used, which not only extend from end to end of the heater, but also, connected by proper wiring, each resistance with its companion on the other heater on the opposite side of the car, so that a single resistance extends not only down one side of the car in both heaters, but also around the car on both sides; in other words, it is intended that from two to three resistances, each one in parallel and independent of the other, extending from end to end of heater, but each one connected in series with that of a companion on the opposite side of the car, shall be used, in order that, when the circuit is closed upon one of them, a certain amount of it will flow, which, of course, with the given number of volts, is inversely as the number of ohms, and the heat resulting from the flow of the current through the resistance becomes equally distributed on both sides of the car, from end to end, thus increasing the amount of heat evolved. Since two or more resistances are then in the circuit, if three resistances are cut in the circuit, the amount of heat will be increased again over that of the other two, and if these resistances have the same number of ohms under all conditions, there will be three times as much current consumed, and, consequently, three times as much heat evolved as when only one resistance alone is used in the circuit. This provision is made in order that the heater may be adopted to any kind of climatic or atmospheric conditions.

With regard to the amount of power required to generate the requisite amount of electricity for the development of the required temperature, it is claimed that 9 amperes of current, equal to about 7½ to 8 horse-power, are used at first, but only for a few minutes, after which but 1¼ amperes are used. The current is controlled by the motor man.

Fig. 2 shows the heater as placed on the Pullman street car—a section of the seat having been removed in order to obtain a view of the heater in position.

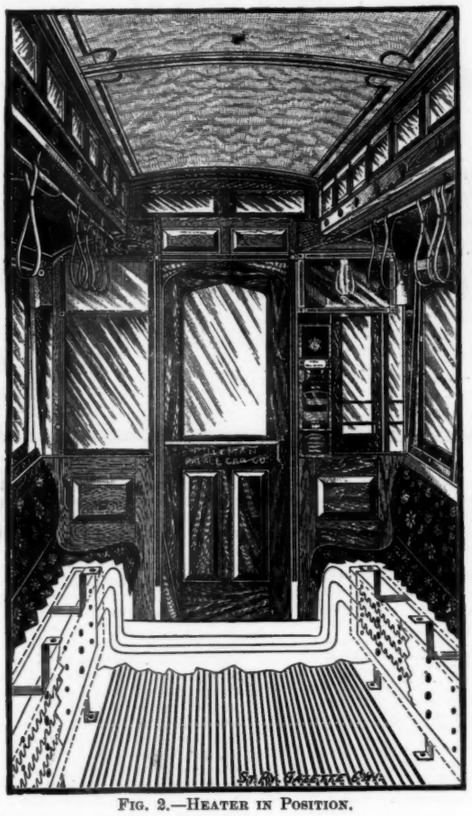


FIG. 2.—HEATER IN POSITION.

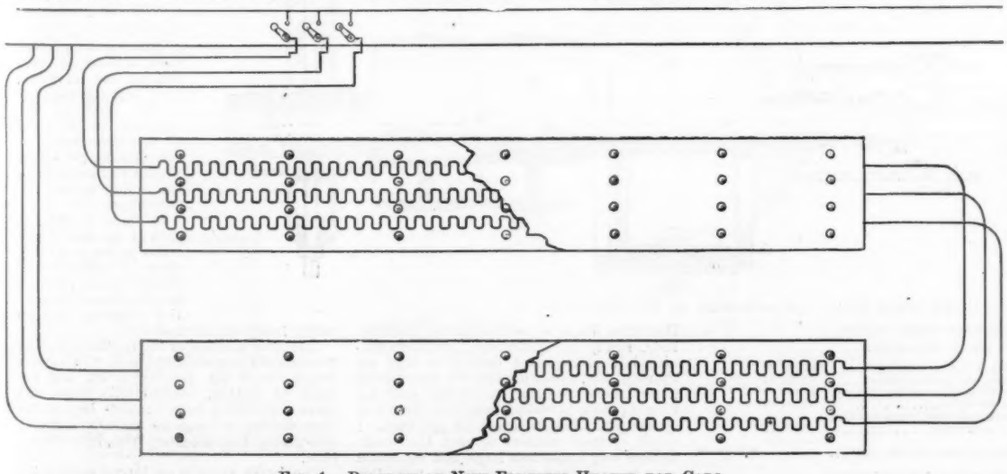


FIG. 1.—DIAGRAM OF NEW ELECTRIC HEATER FOR CARS.

Proposals are wanted until December 19th, 1890, for lighting by electricity and gas the public streets, etc., of the city of Frankford, Ind., for a period of five years. Address S. A. Cook, City Clerk.

—— The Milwaukee *Wisconsin* says that the electric light companies of Milwaukee will consolidate. Then there will be an issue of $5,000,000 bonds, and the stock of the company is expected to be held by the North American Company. Most of the new bonds will be taken by German capitalists. Mr. Villard still holds and will hold the street railways in his own name until consolidation. He has made a payment of $140,000 within a few days. In Minneapolis and St. Paul the Villard electric railways will be pushed rapidly.

—— A suit involving two of the Brush patents was put on trial before Judge Brown, in the United States circuit court, at Cleveland, O., on November 24th. It is that of the Electrical Accumulator Company, of New York, against the Brush Electric Company, alleging infringement of patents on secondary batteries. Both the Faure and the Brush patents were applied for about the same time and the patent office failed to declare an interference at the time. Brush took out two patents and the New York company began two suits, one on each of them. The Brush Company in its answer and cross bill raised an issue in asking the repeal of the Faure patents, whereat the Accumulator Company desired to dismiss both its suits, but this was opposed by the Brush Company. A few minutes before the hearing it was, however, agreed that one of the suits should be dismissed and that the one to be decided by Judge Brown should govern the other.

—— Work on the building at the electric light station in Miles City, Mont., progresses slowly owing to the fact that there is but one brick mason to be had.

—— The Salt Lake City, Utah, Electric Light Company have their new machinery nearly all up, and are now getting into place a 200 horse-power engine. There will be six engines, aggregating 800 horse-power, and 24 dynamos. There are eight incandescent dynamos, aggregating 7,000 lamps, and 16 arc dynamos, aggregating 500 lamps.

—— Among the sales made by the Western Isolated Department, Thomson-Houston system, the following were reported last week: Milwaukee Car Wheel & Foundry Co., Milwaukee, Wis., 20 arc light plant; Democrat Printing Co., Madison, Wis., 100 light incandescent plant; L. E. White (Miller), Greenwood, Cal., 30 arc light plant.

—— The Louisiana Electric Light Company, of New Orleans, La., has one of its large engines running which is developing 1,800 horse-power. The second engine of the same size is on its way. It takes nearly a solid freight train to carry it, the bills of lading calling for 13 cars. The fly-wheel is 28 feet in diameter by 74 inches face, weighs 110,000 pounds, and makes 58 revolutions per minute. The engines are cross compound and 150 pounds of steam pressure is carried on the high pressure cylinder.

ELECTRIC LIGHT NEWS

—— The Electric Light Company, of Phoenix, Ariz., is wiring the Capitol for the use of incandescent lamps.

—— Mr. Henry H. Johnson, superintendent of the Hartford, Conn., Electric Light Company, died last week.

—— During the year 1891 the city of Albany, N. Y., will be illuminated by 88 additional arc lamps, making 569 in all.

—— The Newport, R. I., Edison Electric Illuminating Company is now running the wires for lighting the Summer residences on the Cliffs.

—— The new Corliss engine has arrived for the electric light plant at Springfield, Mass. It is the largest in that part of New England, the capacity being 800 horse-power.

—— The franchise for an electric light plant at White Sulphur Springs, Montana, has been given by the City Council to J. J. Hennessy, the town to be supplied with light within the next 12 months.

—— An interesting course of free Saturday night lectures, at Cooper Union, has been arranged. On December 13, Professor Robert Spice will deliver an illustrated lecture on "How Electricity is Measured."

—— The 60 foot smoke stack at the electric light plant in Steubenville, Ohio, is being increased to a height of 80 feet, which gives the company two chimneys of this size. Smoke consumers will also be added.

—— A new electric lighting company, the Electric Contract Company, has been established in Philadelphia, and has contracted with the Westinghouse Company for the installation of 750 incandescent and 300 arc lights.

—— The Ayer, Mass., Electric Light Company, Dr. B. H. Hartwell, president, intends taking immediate steps toward putting in a system to comprise Ayer, Shirley and Groton. The Groton Episcopal school will also be supplied.

—— At a meeting of the East Chattanooga Tenn., Land Company, held recently, 25 acres of ground were voted to the Thomson-Houston Electric Light and Power Company for the purpose of erecting a large light and power plant. The plans and specifications, as exhibited, are for a handsome pressed brick structure, 150x200 feet, with truss roof.

—— The Edison Illuminating Company, of New York, gave a reception in their Twenty-sixth street station the evening of November 25th to the New York Electrical Society and their friends. The handsome station, which has been illustrated in the ELECTRICAL REVIEW, was examined with interest by the large number of guests present. A delightful lunch was served about 10 o'clock.

—— The most exciting event of the year in Columbia, Mo., has been the vote on the proposition to establish a combined electric light and water plant, the city to have authority to issue $45,000 in bonds for this purpose. The proposition was carried by a vote of 588 to 133. The majority of the large property holders voted against the proposition, and as a number of the leading lawyers affirm that the vote is illegal, the matter will be tested in the courts.

—— The order recently placed by the Union Pacific System, for lighting the shops of the Denver Union Railway & Terminal Co., at Jersey, Col., with the Western Isolated Lighting Department of the Thomson-Houston Electric Co., comprises two 500 light dynamos and other appliances, including wiring necessary to operate 1,100 incandescent lamps. Also an 800 light generator which will be used in connection with an electric motor for running a transfer table.

The Trolley in Boston.

FACTS AND FIGURES WHICH FURNISH FOOD FOR REFLECTION.

The third annual report of the West End Street Railway Company, of Boston, was recently transmitted by the board of directors to the stockholders. As this company operates one of the largest street railway systems in the world (and although only a little over a fifth of this system is equipped with electric power, it is the most extensive electric railway system in existence to-day), the facts, figures and experience with the trolley system as set forth in this report will make interesting reading for every one interested in electric traction. It is a grand and conclusive triumph of the trolley over the horse that admits of no argument. Here are a few extracts from the directors' report, signed by President Henry M. Whitney:

"Early in the year the directors became satisfied that the electric system had passed the experimental stage, and decided to take the necessary steps to introduce this system as rapidly as possible over the lines operated by the West End Street Railway Company.

"It was decided to be for the interest of the company to put in a large amount of power to provide for Winter contingencies and for special occasions, and to build upon a scale which would in all probability meet the demands for some time to come.

"Experience has shown that wherever the electric lines have been installed, travel has enormously increased; and, indeed, travel all over the line increases so rapidly that it is well-nigh impossible for the company to keep pace with the demands upon it.

"The business of the company has increased during the past year to an extent unprecedented in the history of the street railways incorporated in the West End system. The average increase of passengers per day for the whole year was about 30,000 over the previous year; but, large as it was, the business since the first of October has increased in still larger proportion. The number of passengers transported by the street railways in 1880 was about 160,000 people per day; it is now nearly 360,000 people per day, and your directors see no reason why it will not continue to increase in the future as rapidly, or even more rapidly than it has in the past.

"The increased earnings due to this increased traffic, together with the saving of time and other economies in the electric system, fairly justify the company in undertaking to build an elevated railroad."

The following table shows the equipment and mileage of the system for the year:

Box cars	838
" electric	164
Open cars	856
" electric	173
Horses	6,927
Miles track owned	239,450
" leased	16,620
" used conjointly	717
Total miles operated	256,787
Miles of track completely equipped with electric overhead system	65.46
Miles of track partially equipped	27.60
" of feeder lines	74.19
" run during the year	17,665,360
Passengers carried	114,853,081
Round trips run	2,344,570

The revenue miles run by the electric cars during the year were as follows:

Double motor electric cars	2,423,967
Single " " "	345,704
Cars towed by " "	542,072

Total mileage of electric cars, 3,311,743 or 18.75 per cent. of the total revenue miles of the system.

The equipment account includes among others the following items:

ELECTRIC CARS.

This account has been charged with value of 88 box cars and 38 open cars transferred from horse car equipment, $107,000; also with cost of 131 new open electric motor cars, and 33 new box electric motor cars, together with all motor and electric equipments for the same and for horse cars converted to electric cars, also cost of drawbar equipments and alterations of 119 horse cars to serve as tow cars, $934,974.58. Net charge to this account for the year, $1,041,974.58.

Snow Equipment, covering cost of 3 snow plows, 7 electric sweepers, 1 electric coal car, 50 snow sleds, 16 levellers, 1 derrick wagon, 1 pole wagon, 7 wagons, 8 carriages, 2 sprinklers, $40,872.82; new machinery, tools and miscellaneous equipment, $4,688.46; total, $45,561.28.

POWER STATION EQUIPMENT.—CHARGES.

Central Power Station—Steam Equipment	$76,254 45	
Electrical Equipment	59,894 80	
Allston Power Station—Steam Equipment	4,674 96	
Electrical Equipment	6,210 81	
E. Cambridge Power Station—Steam Equipment	32 00	
Electrical Equipment at Edison Electric Ill. Co.'s Station.	26,879 27	
Electrical Equipment at Camb. Electric Lt. Co.'s Station	24,805 31	
	$198,751 60	
CREDITS.		
Electrical Equipment, Allston Power Station transferred	8,000 00	
Net increase of account for the year		$190,751 60

ELECTRIC LINE EQUIPMENT—CHARGES.

Wiring Tracks underground	$58,960 88	
Poles, and setting same	70,692 64	
Overhead Electric Equipment	59,120 28	
Feeder Lines	50,804 69	
Tools and Equipment for Line Construction	3,658 77	
Total account for the year		243,237 26
Net increase of General Equipment account for the year		$468,561 57

Notwithstanding the heavy increase in the equipment account for the year, President Whitney in an address delivered by him to the stockholders showed that the adoption of electric power on a little over a fifth of the system had increased travel on the lines 44.1 per cent. Here are some further extracts from the address mentioned above:

"Our experience with electricity during the last year has more than justified the expectations of the company and the directors, as reported to the stockholders a year ago. We find that wherever electricity is put in, the number of passengers to be carried increases very largely, showing, to our mind, the great satisfaction that the electric service is giving.

"I was curious to see where the increased travel of this year came from. Now, a little more than one-half of the first division is equipped for electricity. If I remember rightly, the earnings there for the month of October were about $70,000 by electric lines, and about $50,000 for horse lines. Well, now, taking the lines which are now operated by the electric system, but which were last year operated by horses, the increase in the travel this year has been 44.10 per cent. Just within the time mentioned, it has increased this much, and I know of no reason why it should not continue. So that, while we have provided what seemed to us ample facilities for those people, although we have given them more cars, more frequent trips, yet the travel has come in so rapidly that the travel over these routes that are now run by electricity and were last year run by horses, has increased over 44 per cent. The increase of travel on that whole division, by both the horse and electric lines, has been 27.37 per cent.

"The same is true of Cambridge. In Cambridge we hold that the electric system has not had quite a fair chance, because we are limited as to the speed on Main street, and there have been certain prejudices against the line that I think time will overcome; at any rate, I hope it will. But notwithstanding that, the increase of travel over last year has been 16 per cent. Our Brookline and Allston lines have shown the most remarkable growth. For, although the Brookline lines were started in January, 1889, nearly two years ago, and were running last year almost exactly as they are running now, excepting that we are running a few more cars, the travel this year for these 41 days, in comparison with the travel of last year, has increased 73 per cent. I speak of these matters so that the stockholders may know how large and important are the questions in connection with this travel with which we have to deal.

"In this connection, it is proper that I should call your attention to the great growth of this business, and the great number of people that desire to travel if only they can have the opportunity. Now, given the electric system to points in Charlestown, Somerville, Malden, Melrose, and to Upham's Corner, Field's Corner, Dorchester, South Boston and everywhere else, I do not know why the experience, which I have detailed, should not be reported throughout the whole system. I do not know why, if we can have better and quicker transit, the same experience in regard to increased travel should not be felt throughout the whole system that we have experienced in the portion of the line already equipped with the electric system.

"But what are we going to do? The question which this board and these stockholders must consider is, what shall be done with this great increase in travel? I have no question at all that within three years from this time we shall be called upon to carry from 30 to 50 per cent. more people than we do now. If our travel is growing over our electric systems at the rate of 10, 20, 30, 40 and 50 per cent., it seems to me absolutely certain that within three years we shall be called upon to carry from 30 to 50 per cent. more of people on the surface. What shall we do with them? That is the question. Where shall we bring them to and where shall we leave them? Is there any more room on Washington street or Tremont street to put cars. Fifty per cent. more of people means from 175,000 to 200,000 people more a day. Anybody looking back at the past history of the travel in and out of Boston over these lines, looking at it since October 1, on these statistics which I have presented—and they are facts—everybody who will concede that the experience of the past is a fair basis for an estimate for the future, must agree that there will be carried into this city from 175,000 to 200,000 people a day more than we are now carrying."

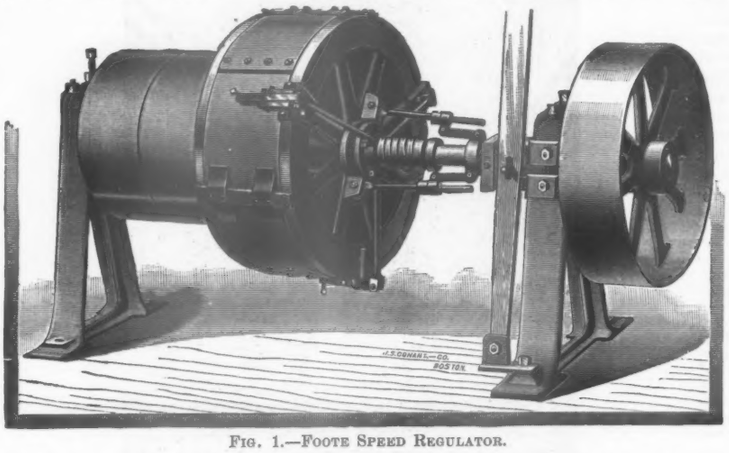


FIG. 1.—FOOTE SPEED REGULATOR.

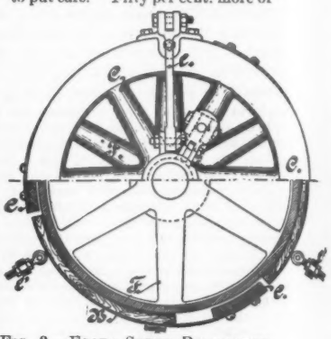


FIG. 3.—FOOTE SPEED REGULATOR. —END SECTION.

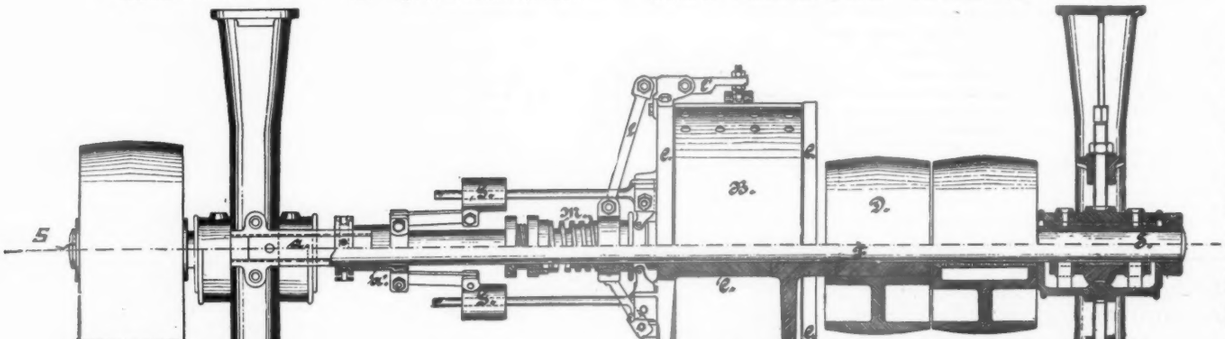


FIG. 2.—FOOTE SPEED REGULATOR.—SECTION OF COUNTERSHAFT.

The Foote Speed Regulator.

Chandler & Littlefield, who have opened an office in the Marine Building, Chicago, have received a number of novelties, prominent among which is the T. M. Foote speed regulator. The following description, with illustrations, shows the merits of this novel device:

The main features of the regulator are a friction coupling between the driving pulley and the shaft to be driven, and a governor which controls the pressure of the friction.

The drawings, which show a side elevation and an end elevation, both being partly sectional, represent the regulator in the form of a countershaft. It can thus be placed on the floor or hung from the ceiling to suit circumstances.

In Fig. 2 the driving pulley is marked *D*, and is fast on the projecting sleeve of friction wheel *F*—the two forming one member of the friction coupling, and rotating freely on the shaft *S S*.

The other member of the friction coupling consists of three brake shoes *B*, which cover two-thirds of the friction wheel and are made of leather, backed with wood and sheet steel, which latter projects beyond the shoe, serving to fasten the same to carrier *C*, and giving the necessary elasticity to the shoe.

The brake shoes *B* are forced against the friction wheel *F* by the spring *M*, which acts through levers *l* and *l'*, levers *l'* having their fulcrums on the carrier *C*, which is fast to shaft *S S*, so that they all rotate together.

The arms of the governor, *G G*, at their fulcrums have each an extension at right angles, which press against the spring *M*, so as to diminish the pressure of the same on the combination of levers *l* and *l'* and brake shoes *B*.

The relative tension of the spring *M* and the amount of the weights on the arms of the governor are determined and adjusted according to the horse-power and the speed that is desired.

New Conduit System.

BY C. K. HARDING, OF ATLANTIC, IOWA.

The increased interest shown in electric propulsion at the recent convention of the American Street Railway Association, may serve as an excuse for bringing to your notice an improved conduit system, which, although new, is, I think, destined to play an important part in the solution of the problems met in the practical application of electricity to urban passenger transportation.

As the case now stands in the larger cities, where rapid transit is the most necessary, the use of overhead wires, which have hitherto been the only practical method of operating electric street railways, is prohibited; and when we consider the many objectionable features of overhead wires—their danger to life from lightning, their interference with other wires, and their unsightliness, we should not be too hasty in our judgment of the authorities who prohibit them.

In looking for the weak points of electric railways we will adopt the natural classification made by Dr. Allen in his paper before the convention, *i. e.*:

1. The Central Station.
2. The Motors.
3. The Transmitting Lines.

In the first division there is little more to be desired. We have good engines and efficient generators, and with a system practical in the larger cities, the increased number of cars will make the sometimes very severe variation of load relatively much less—thus avoiding the trouble at the central station.

In the second division, the electric car motors are not all that could be desired. The noisy and expensive gearing which a high speed motor renders necessary, and the duplication of motors on the same car are objections that need not exist in a system using a higher voltage, which would admit of the use of a slow speed motor, with a free running armature and direct gearing, without increasing the weight of the motor beyond a desirable point, or necessitating the employment of a special car for carrying it.

And here we come to the third division, the transmitting device for supplying the current from a central station to the moving car.

And here is the primary cause of all the trouble.

An ideal system would be the overhead wire freed from its objections, which are:

Danger to life and property.

The limitation of voltage made necessary by defective insulation at the expense of economy and distribution.

The liability of dynamos and motors being destroyed by lightning, which no lightning arrester can protect.

The inductive interference with telephones, which exist with all but double trolley systems; and lastly, the unsightliness and expensive maintenance of a system of overhead wires and guards.

Storage battery systems overcome a large number of these objections, but contain others which are hardly less important.

The main fault is, however, their lack of economy, caused by the roundabout way of applying the current, and the imperfect manner of storing it.

The fact that with a multitude of enthusiastic supporters, for a number of years, it has failed to make any important advances, or to be used on other than a small scale, speaks louder than any criticism for its inefficiency.

Even if the batteries could be made several times more efficient, it could never hope to compete with the direct method, especially one with improved insulation and carrying a high voltage, which could distribute over large areas with practically no loss or drop of potential, caused by the resistance of the conductors. It was to overcome some of the disadvantages above referred to, that I devised the conduit system which I will now describe.

My invention embraces, as its principal features, a continuous main or supply conductor, insulated and protected in the tubular lower part of a casing, a cross section of which is shown in Fig. 2; and a series of working conductors, insulated and supported in the top channel of the casing, with their upper surface exposed and adapted to come in contact with brushes on the car—and electro-magnetic contact making devices, for bringing the conductor sections separately and successively into electric connection with the main insulated supply conductor. These contacts are arranged to be operated by a very small current, derived from the main conductor and extending through branch wires to the adjacent sections; thence through the forward brush to a rheostat on a car, and thence to ground or a return conductor. Fig. 1 shows a working plan of the apparatus; the car itself is supplied with two brushes, at a distance apart, equal to the length of a section of the working conductor, which is laid centrally between the tracks.

The ends of the section are separated by

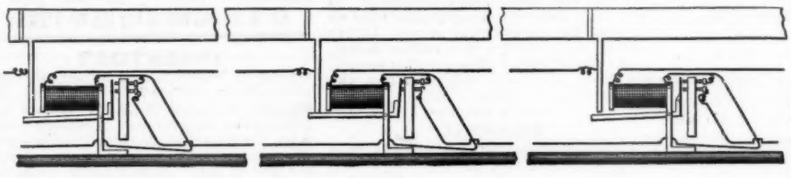


Fig. 1

insulated material, and the contact length of each collector is sufficient to overlap this insulation and momentarily receive current from two adjacent sections. As a matter of fact, these collectors are intended each to consist of a pair of small wheels running on the supply rail.

Closed at the start, a single one of the switches throws current into one of the sections on which the car rests, and thereafter, whether the car is moving or at rest, the operation of the parts is entirely automatic. Fig. 1 shows three sections of the track and three of the automatic switches. It will be seen that this switch consists of an electro-magnet, furnished with an armature which serves to lead the current to a projection from the working conductor.

The opposite end is turned upward at right angles, and forms another switch of which the purpose will be seen later. The terminals of each magnet are connected, respectively, to the preceding and succeeding sections of the working conductor, to the former through the contact devices shown, and directly to the latter.

Suppose now the switch of the left hand section, shown open, to be closed, and the rear collector of the car to be just leaving the section, while the forward collector is just passing from the central to the right hand section shown. Current now passes into the first section of the working conductor through the closed switch, and also through the double contacts connected together by the rear end of the magnet armature through the small connecting wire, to and through the magnet of the middle section, and thence to the car, through the forward part of the forward brush. Thus the magnet of the central section will be energized and its armature attracted, closing the switch and letting the current pass from the supply conductor to the central section of the working conductor; but as soon as this switch is closed, the magnet of the first section is shunted around by the low resistance of the direct connection between the supply conductor and the central section of the working conductor.

Hence its armature falls, and falling breaks all connection with the first section and leaves it insulated.

As the car passes on, this operation is successively repeated through the following sections.

The result of this arrangement is a continuous supply to the sections immediately under the car, the remainder of the working conductor being insulated, consequently there is but little tendency to leakage, and the insulation usually so difficult, becomes comparatively simple. It will be readily understood that neither moisture nor a conductor accidently coming in contact with a section of the working conductor, and grounding it, would cause a short circuit, nor maintain one after the car had passed; and this is an essential feature possessed by no other system using a sectional rail method of supply.

The simplest form of electro-magnetic contact device would be one in which the magnets would be in series with the motor, but this would require magnets of a large size, wound with a coarse wire and would require a large amount of current to maintain the contact when the car was stopped, and would be liable to sparking and sticking at the contacts. By the arrangement of the magnets in multiple arc, I am enabled to use small magnets wound with fine wire, and to put the whole contact device in a junction box about 3x3x4 inches, formed by an enlargement of the lower tube. These devices are simple and inexpensive, and may be wound with iron wire, and are adapted to be interchangeable. The whole conduit may be made complete in sections four to six feet long, and coupled together and put into position in center of the tracks, without disturbing the track rails already down; the conduit being only about seven inches high.

It will be seen that the conduit is entirely closed, the main wires imbedded in insulating material in the lower part, and the conductor sections in the upper flaring portion; thus avoiding all the mechanical and electrical difficulties of a slotted arrangement, which is apt to become filled with snow, ice, sleet, mud, etc.

The forward part of the car of my system is preferably supplied with a small revolving brush, which sweeps the top of the conduit, and keeps the conductor sections clean.

The absolute safety of this system cannot be questioned, as the only sections that can carry current are those immediately under the car, and protected by it.

The path for the return current is preferably through the iron casing and the track rails, thus forming a parallel return, which acts the same as a double trolley system, in avoiding inductive interference with telephones.

And the placing of the main wire underground is the only way that it can be effectually protected from lightning.

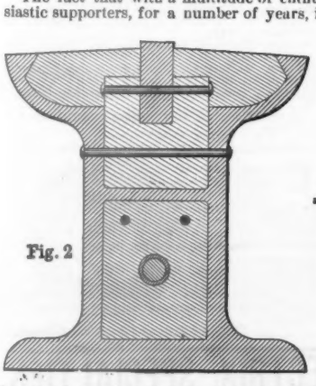


Fig. 2

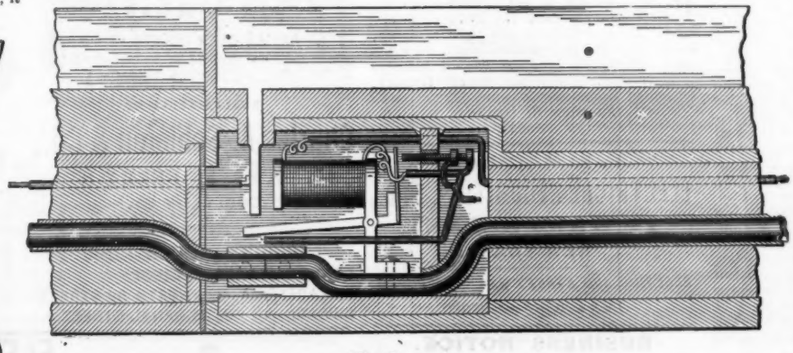


Fig. 3

Electric Lighting at Monaco.

The concession for lighting Monaco, we learn from a foreign contemporary, has been granted to the firm of Lombard Gerin, Lyons. The concession is for 50 years, when the material in the public highways will become the property of the town, who will also be empowered to purchase the station at a price to be fixed by valuation. After 25 years the government can insist on the method of distribution being reorganized and brought up to the standard of progress then existing. Authority is given to use the Zipernowski system with a maximum pressure in the primary circuit of 3,000 volts, and in the secondary of 120 volts. Earth returns are prohibited. The government will give the site for the station, which is to have a capacity of 50,000 incandescents, and the ground required for conduits.

ELECTRIC CLUBS.

New York Electric Club.

A Dinner, it is announced, will be given at the Electric Club, Thursday evening, December 4th. Each member is entitled to bring one guest. There will be after-dinner speeches, and music, etc., provided by the Committee on Entertainment.

It is the Intention of the committee to have these social occasions alternate every two weeks with the regular monthly lectures of the Club, which occur every third Thursday. There will undoubtedly be a large attendance at the dinner this week.

Mr. Geo. L. Wiley gave a charming little dinner to 30 of his friends one evening last week. It was served in an upstairs parlor, and was one of Steward Stadler's best efforts.

Wisconsin Electric Club.

At a Meeting of this Club, held at their rooms in Milwaukee, on November 20, J. A. McManman, electrician of the Wisconsin Telephone Company, read an interesting paper on "The Telephone." He gave an account of the first telephone of Prof. Alex. Graham Bell, and its introduction for commercial use in New York by Mr. Holmes, who established the first telephone exchange. Mr. McManman showed how the present telephone switchboard had been greatly improved over the original ones. He said that it is now proposed to use a glass switchboard, which will accommodate 24,000 metallic circuits over an area of 3x5 feet. He also spoke of the great improvements that had been made in long distance telephony. Mr. McManman alluded to the trouble the telephone people had experienced since the introduction of electric street cars and the placing of their wires underground. The first difficulty was being overcome by introducing a metallic circuit or a return ground wire. The second difficulty resulted from the static capacity, and had not yet been eliminated. The speaker described the bridging system, whereby as many as 20 stations could be placed on one line.

American Chemical Society.

The second general meeting of the Society will be held at Philadelphia, December 30th and 31st, in the buildings of the University of Pennsylvania. Chemists, chemical manufacturers, and all persons interested in chemistry, will be heartily welcomed at the meetings.

Ball Lightning.

M. Von Lepel produces ball lightning with an influence machine as follows, says London *Electrical Engineer:* Two thin copper wires connected to the poles of the machine are kept at a certain distance from the opposite sides of a plate of mica, ebonite or glass, when little red luminous balls appear which move hither and thither, sometimes quickly, sometimes slowly, occasionally remaining still. The best effects are obtained with a plate of glass or paper disk painted with paraffine. M. Von Lepel is of opinion that small liquid or dust particles are the vehicles of the luminous phenomenon. A light breath of air will cause the balls to disappear with a slight crackle. These results can only be obtained with weak pressure, for when this is increased the ordinary spark discharge occurs.

The track mileage of street railways in the five leading cities of the United States is said to be as follows: New York, 368; Chicago, 365; Boston, 329; Brooklyn, 324; Philadelphia, 324. Three cities have elevated roads: New York, 32 miles; Brooklyn, 24 miles, and Kansas City, 5 miles.

The new through telegraph line from Bombay to Calcutta, *via* the Bengal-Nagpore Railway, is expected to be opened on April 1st next.

KINDRED INTERESTS

Cleverly, Philadelphia, is the first in the field with a handsome steel engraved calendar for 1891. We have received one.

The Eddy Electric Company, of Windsor, Conn., are unusually busy at present, and are taxed to their utmost capacity. It has been decided to build a large addition to their building in the Spring.

Mr. C. M. Blanchard, electrical contractor and engineer, of Philadelphia, has sent us a handsome group of nine photographs, showing various views of the Jenkintown, Pa., electric light station. It is a model plant.

The Direct United States Cable Company, through Manager Brown, has sent us a very handsome picture in a neat frame advertising the company. It is an English color print and is rather a novelty on that account.

Charles A. Schieren & Company, of this city, have just furnished the Louisville Cotton Mills, Louisville, Ky., 89 feet of 32 inch three-ply patent perforated electric leather belting. This is very heavy for a perforated belt. No one has ever sent Schieren & Company an adverse criticism of this belting.

W. R. Fleming & Co., 174 Fulton street, New York, agents for Ide and Ideal engines built at Harrisburg, Pa., have just closed a contract for a complete steam plant for the Augusta Mining Company, of New York. The plant will consist of two Ide engines, boilers, etc., aggregating 100 horse-power. Other sales this week are reported as follows: One Ide engine 50 horse-power, Vesuvius, Md.; one 70 horse-power steel boiler and one 20 horse-power Ide engine for Chas. Avery, New York; one 20 horse-power Ideal for Edison Machine Works; one 30 horse-power engine, Staten Island. A number of orders were also taken for shafting of William Sellers & Co., and belting of the Jewell Belting Co., for both of whom Fleming & Co. are selling agents.

Electric Lighting at St. Pancras.

The first stone of an electric lighting station was laid at Stanhope street, St. Pancras, on Wednesday last, says *Industries*. The work is being carried out by the vestry, who alone of all the London vestries have retained the powers for electric lighting in their own hands. Professor Henry Robinson, the engineer of the work, informs us that the station will be supplied with nine low tension and two high tension dynamos, one of each set being reserved as a standby. All these dynamos will be driven direct by triple expansion condensing engines. The high tension dynamos will be used to supply ninety 500 watt arc lamps for street lighting. The low tension dynamos are for the incandescent lamp circuits, and the distribution will be effected on the three wire system, at a potential of 110 volts between the lamp terminals. The low tension plant will be equal to serve as a maximum 10,000 incandescent lamps of 16 candle-power each. As an additional standby, and for use during the period of minimum demand, six sets of accumulators, equal to supplying 800 to 900 lights, are also to be placed in the station. Provision has been made at the outset for laying five miles of distributing mains, which will be capable of carrying sufficient current for 25,000 sixteen candle-power lamps, so that when required the plant at the generating station can be more than doubled without necessitating the laying of fresh mains.

Storage Battery Combine Denied.

A New York daily newspaper recently printed this paragraph:

"It is reported that in connection with recent important discoveries, relative to the development of power from electrical storage batteries, a syndicate has been formed to control all of the storage battery patents. It is said that those who control the new invention have undertaken an amalgamation of all similar interests, because they fear that the new appliance is, in certain respects, an infringement of some of the existing patents. Those who are conversant with the movement predict that the combination of all storage battery patents will insure the unqualified success of the idea of carrying electrical power for transportation and other purposes."

When shown the above by a representative of the ELECTRICAL REVIEW, Mr. Truex, of the Electrical Accumulator Company, 44 Broadway, this city, said: "Our company knows nothing of any combination; we are outside of any such deal. We think we own the patents under which the best storage battery of to-day is made. The Electrical Accumulator Company was first in the storage battery field in America, having begun business in May, 1886. We have nothing to gain by entering into a combination with other makers."

The Consolidated Electric Storage Company, 120 Broadway, this city, was organized last June to manufacture storage batteries under the patents of Brush and Julien. Mr. William Bracken, president of this company, said: "I know nothing about a combination except what I have seen in this item. My company has no knowledge that any such deal has been or will be made. It isn't likely that we would purchase what we consider the fundamental storage battery patents for a quarter of a million dollars, spend another half million on other patents, and then join hands with other men who have nothing to offer us."

FINANCIAL.

Closing quotations of electric stocks, from F. Z. Maguire & Co., Electrical Securities, 18 Wall street, N. Y., Saturday, November 29, 1890. New York, Boston and Washington Stock Exchanges. Pittsburgh closing November 28, 1890.

NEW YORK.	
Western Union Telegraph Co.	78.
American Telegraph & Cable	83.
Central and South American	155.
Mexican	210.
Commercial Cable Co.	101.
Postal Telegraph Cable	39.
Edison General Electric Co.	85.
" " " Deferred	
Consolidated Electric Light	
Edison Electric Illuminating Co.	
United States Electric Light	30.
North American Phonograph	30.
BOSTON.	
Thomson-Houston Electric Co.	42⅝.
" " " Preferred	95¾.
" " " Series C	
" " " Series D	5⅝.
" " International Co.	
" Welding Co.	
" European Welding Co.	
Ft. Wayne Electric Co	11.
TELEPHONE:	
American Bell	215.
Erie	47.
New England	
Mexican	.75
Tropical American	
MISCELLANEOUS:	
Edison Phonograph Doll	1¼.
WASHINGTON.	
Pennsylvania Telephone	25.
Chesapeake and Potomac	
American Graphophone	12.
United States Electric Light (Washington)	140½.
Eckington and Soldiers' Home Electric Ry.	59¾.
Georgetown and Tennallytown	48½.
PITTSBURGH.	
Westinghouse Electric Mfg. Co.	20⅝.

WANTED.—A practical and theoretical electrician to superintend and operate electrical mining plant. Must give good references.

Address: **"T."**

CARE OF ELECTRICAL REVIEW, N. Y.

IF YOU HAVE A BATTERY—Gravity or Leclanche—use the Delany battery strip. It prevents the salt from creeping, keeps batteries and shelves clean, prevents local action, and prolongs life of battery. Warranted. Price per dozen—Gravity, 60 cents; Leclanche, 50 cents.

PATRICK B. DELANY,
SOUTH ORANGE, N. J.

F. Z. MAGUIRE,
ELECTRICAL SECURITIES, ETC.,
18 WALL STREET,
NEW YORK.

ELECTRIC AND STREET RAILWAY PROPERTIES BOUGHT AND SOLD.

BUSINESS NOTICE.

THERE ARE MANY ELECTRICAL companies in different parts of this country who use as their trade name, or as a part of such name, the words "Electrical Supply." This necessarily causes considerable confusion, which it is claimed, is injurious to the interests of The Electrical Supply Company, of Chicago. This company, as the first to adopt this trade name, have now brought suit against the Great Western Electric Supply Company to establish their titular rights against infringement. They will also bring suit against other companies using all or a part of their trade name, hoping to establish in the courts their exclusive rights to the use of all parts, however arranged.

THE LAW BATTERY

IS THE CHEAPEST BATTERY ON THE MARKET.

We think twice before spending a Dollar and would advise you to do the same. We make a specialty of Pure Zinc and Pure Sal-Ammoniac.

LAW TELEPHONE CO.,
85 & 87 JOHN ST., NEW YORK.

INVENTORS

Coming to Washington to further any electrical patents, will profit by calling on **C. W. Messner, of 1225 F St., N. W.** All the appliances necessary for tests, experiments, etc. Also, Electrical Contractor and Constructor. Special attention to isolated plants. Agent for the "C. & C." electric motor—sizes, ⅛ to 50 horse-power. The only electric motor on the market to-day.

"I advise all parents to have their boys and girls taught shorthand writing and typewriting. A stenographer who can typewrite his notes would be safer from poverty than a great Greek scholar."—CHARLES READE, on "The Coming Man."

REMINGTON
STANDARD TYPEWRITER.

For 15 years the Standard, and to-day the most perfect development of the writing machine, embodying the latest and highest achievements of inventive and mechanical skill. We add to the Remington every improvement that study and capital can secure.

Wyckoff, Seamans & Benedict,
327 BROADWAY, NEW YORK.

PATENT PERFORATED
ELECTRIC
LEATHER BELTING

MANUFACTURED BY

Charles A. Schieren & Co.,
45, 47, 49, 51 FERRY ST.,
COR. CLIFF ST.

BRANCHES:
BOSTON, 119 HIGH STREET.
PHILADELPHIA, 226 NORTH 3d STREET.
CHICAGO, 46 SOUTH CANAL STREET.

ELECTRICAL PATENTS

INDEX OF INVENTIONS FOR WHICH LETTERS PATENTS OF THE UNITED STATES WERE ISSUED ON NOVEMBER 25, 1890.

441,122 Contact trolley for electric railways. 441,123 Trolley for electric railway cars; Norman C. Bassett, Lynn, Mass., assignor to the Thomson-Houston Electric Co. of Connecticut.

441,127 Manufacture of incandescent electric lamps. 441,128 Incandescent electric lamp; Adolph Bornholdt, Brooklyn, N. Y.

441,130 Electric battery connections; Horatio J. Brewer, New York, N. Y.

441,157 Electrical call, lighting and alarm system; Chas. A. Hale, Cleveland, O.

441,210 441,211 Electric street railway system; Malone Wheless, Nashville, Tenn., assignor, by direct and mesne assignments, to the Wheless Electric Railway Co., Alexandria, Va.

441,212 Conduit for electric railways. 441,213 Auxiliary contact for electric railways. 441,214 Electric railway cut-out. 441,215 Insulated brake. 441,216 441,217 441,219 Electric railway system. 441,218 Electro-magnetic switch for electric railways; Malone Wheless, Nashville, Tenn., assignor to the Wheless Electric Railway Co., Alexandria, Va.

441,220 Trolley for underground electric railways. 441,221 Conduit for electric railways; Samuel E. Wheatley, Washington, D. C., assignor to the Wheless Electric Railway Co., Alexandria, Va.

441,246 Armature body; Chas. A. Lieb, New York, N. Y.

441,248 Means for hanging electric lights; Timothy J. Lynch, Danvers, Mass.

441,256 Dynamo brush clamp; Thos. Reese, Jr., Newark, N. J.

441,258 Conduit for electric railways; Nicholas Seibert, Malden, Mass.

441,293 Rheostat; John Doyle, Hoboken, N. J., assignor to the North American Electric Co., New York, N. Y.

441,304 Annunciator; Chas. W. Holtzer, Brookline, Mass.

441,305 Electrically propelled vehicle; Rudolph M. Hunter, Philadelphia, Pa.

441,312 Suspending device for electric wires; Walter B. Marks, John G. Lauer and Robt. R. Ralston, Richmond, Va.

441,350 Method of operating electric brakes for electrically propelled cars; William M. Schlesinger, Philadelphia, Pa.

441,391 Method of winding dynamo armature; Chas. E. L. Brown, Zurich, Switzerland.

441,396 Telephone; Frank L. Capps, Springfield, Ill., assignor of one-half to Albert L. Ide, same place.

441,401 Method of electric welding and metal working; Mark W. Dewey, Syracuse, N. Y., assignor to the Dewey Corporation, same place.

441,403 Galvanic battery; Oscar A. Enholm, New York, N. Y., assignor, by direct and mesne assignments, to the Enholm Electrical Construction Co., same place.

441,413 Secondary battery; Geo. E. Hatch, Cambridge, Mass., assignor to David H. Burrell, Little Falls, and Jean R. Stebbins, Watertown, N. Y.

441,458 Automatic electric gas lighter, Le Roy S. White, Waterbury, Conn., assignor to the Electrical Appliance Manufacturing Co., same place.

441,457 Wire joint for commutators; Walter E. Harrington, Atlantic City, N. J., assignor of one-half to Leonard Atwood, Philadelphia, Pa.

441,488 Pyrometer; William S. Hensley, Cardiff, and William H. Grindley, Tunstall, England.

441,542 Device for transforming and controling electric currents; Oscar A. Enholm, New York, N. Y., assignor, by direct and mesne assignments, of six-tenths to Julius M. Heyman, Geo. W. Venable and Moses J. Heyman, all of same place.

441,543 Arc lamp; Oscar A. Enholm, New York, N. Y., assignor of one-half to Julius M. Heyman, same place.

441,565 Electrically propelled vehicle; Rudolph M. Hunter, Philadelphia, Pa., assignor to the Electric Car Co. of America, same place.

441,571 441,572 Electric railway; Hosea W. Libbey, Boston, Mass.

441,588 Electrical switch; George Schultz, Old Charlton, England.

441,609 Machine for paring and polishing phonograph cylinders; Geo. A. Beach, Sioux City, Iowa, assignor of one-fourth to Chas. Dickinson, Chicago, Ill.

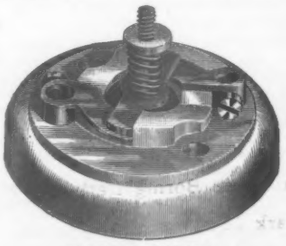
441,622 Electrical thermostat; Chas. H. Shaffer, Rockford, Ill.

YOU make a mistake if you don't buy your Electrical Supplies from F. & F., Cleveland, O.

LOOK AT THESE PRICES:

$2 Electric Bells, 50c., 75c. Bronze.
Push Buttons, 25c.; 25c. Wood Push.
Buttons, 7c.; 50c. switches, 15c.
40c. Bell Hangers' Staples, per lb., 10c.
$1 Leclanche Batteries, 45c.
$1 Carbon Batteries, 40c.
$3.75 Spark Coils, $1.50; $10 Medical Batteries, $3.50.
Dry Batteries, Motors, Dynamos and Annunciators at half price. Send for reduced price list and discounts.

Fletcher & Fletcher Electric Co., Cleveland, O.



ELECTRIX SWITCH.

ELECTRIX SPECIALTIES.

Endorsed the World over by Users.

Simple. Reliable. Indestructible.

DEALERS REPORT QUICK SALES.

CORRESPONDENCE INVITED.

THE STAR ELECTRIX CO.,

1320 Wallace St., Philadelphia, Pa.

AN EXCELLENT ARTICLE.

The P.&B. TRADE MARK REGISTERED INSULATING TAPE.

MANUFACTURED ONLY BY

THE STANDARD PAINT CO.,

59 Maiden Lane, New York.

Daniel W. Baker. Cyrus O. Baker, Jr.

BAKER & CO.,

Importers, Melters and Refiners of

PLATINUM,

408, 410, 412 and 414 N. J. R.R. Ave., NEWARK, N. J.

Platinum in sheet and wire, all sizes, and any degree of hardness. Scrap and native platinum purchased

SUPPLIES FOR ALL SYSTEMS.

Prompt Shipments. Write for Prices.

W. H. GORDON & CO.,

ELECTRIC LIGHT AND POWER SUPPLIES,

SIMPLEX WIRES. *115 Broadway, New York.*

INTERNATIONAL ALUMINUM WORKS,

Manufacturers, under Prof. H. G. Coyle's Processes, of

Aluminum Electroplating Solutions and Anodes.

(PATENTS APPLIED FOR.)

COMPLETE OUTFITS FOR ALUMINUM ELECTROPLATING A SPECIALTY.

County and State Rights Sold. No Royalty.

Offices, 36 & 38 JOHN STREET, NEW YORK, U. S. A.,

And 86 New Street, Birmingham, England.

LABORATORY AND SHOW ROOMS, 53 MAIDEN LANE, NEW YORK.

STANDARD RESISTANCE COILS.

STANDARD MEGOHM COILS.

Accurate within 1/10 of 1 per cent.

Specially adapted for measuring the insulation of

ELECTRIC LIGHT CABLES, AERIAL CABLES,
UNDERGROUND CABLES, SUBMARINE CABLES.

Send for Catalogue 1-66 of Electrical Test Instruments.

QUEEN & CO., PHILADELPHIA.

The Burton Electric Heater for Electric Railway Cars

NO SMOKE! NO GASES! EASILY MANAGED! ECONOMY IN SPACE!

Normal use of current, THREE AMPERES, and the cost of this is in the coal burned at the generating station, which is actually LESS than that of coal burned in a stove on a car.

"They are giving us and the public entire satisfaction."—RICHMOND, VA., U. P. RY. Co.
"The heat is pleasant, sufficient and economical."—MARLBOROUGH, MASS., STREET RY. Co.
"We are much pleased with them, and know of no reason why we shall not continue to use them and recommend them to others."—ST. LOUIS AND EAST ST. LOUIS ELECTRIC RY. Co.

AGENCIES: Equitable Electric Ry. Construction Co., 416-420 Commercial Union Building, Phila., Pa.
Higgins Brothers & Co., 202 Main Street, Buffalo, N. Y.
Electric Merchandise Co., 11 Adams Street, Chicago, Ill.
St. Louis Car Co., St. Louis, Mo.

For Further Information, Address,

THE BURTON ELECTRIC COMPANY, RICHMOND VA

GRIMSHAW WHITE CORE INSULATED WIRE

Grimshaw Patented White Core WIRES and CABLES.

FIRE, ACID, AND WATERPROOF. *GRIMSHAW TAPE.*

NEW YORK INSULATED WIRE Co.,

R. E. GALLAHER, Secretary. Sole Manufacturers,
J. W. GODFREY, Gen'l Manager.
W. B. DOWSE, Treasurer. 649 & 651 BROADWAY, N. Y.

THE HORIZONTAL

Drilling and Boring Machine

IS A SPECIAL TOOL FOR BORING THE

FIELDS and BEARINGS of DYNAMOS and MOTORS.

Its Product Exceeds that of Three Boring Lathes.

Send for particulars to the Newark Machine Tool Works,
NEWARK, N. J.

EUGENE F. PHILLIPS, PRESIDENT. W. H. SAWYER, SEC. & ELECTRICIAN.

AMERICAN ELECTRICAL WORKS,

Manufacturers of Patent Finished

ELECTRIC LIGHT WIRE,

MAGNET WIRE, OFFICE & ANNUNCIATOR WIRE.
RUBBER COVERED WIRE, LEAD ENCASED WIRE,
TELEPHONE & INCANDESCENT CORDS.

FARADAY CABLES.

Office and Factory, 67 STEWART STREET., PROVIDENCE, R. I.
New York Office, 10 Cortlandt St., P. C. Ackerman, Agt.

EUGENE F. PHILLIPS, PRESIDENT. JOHN CARROLL, SEC'Y-TREAS.

EUGENE F. PHILLIPS ELECTRICAL WORKS, LTD.

Manufacturers of

ELECTRIC LIGHT WIRE,

MAGNET WIRE, OFFICE & ANNUNCIATOR WIRE,
RUBBER COVERED WIRE, LEAD ENCASED WIRE,
TELEPHONE & INCANDESCENT CORDS.

FARADAY CABLES.

OFFICE AND FACTORY St. Gabriel Locks. MONTREAL, CANADA.

PHŒNIX GLASS CO

OF PITTSBURGH, PA.

MANUFACTURERS OF A FULL LINE OF

ELECTRIC LIGHT

GLOBES SHADES

BOTH ARC AND INCANDESCENT.

RICH CUT, OPAL, CLEAR, ETCHED, ROUGHED, ETC.

ADAPTED TO ALL SYSTEMS.

729 BROADWAY, NEW YORK.
(COR. WAVERLY PLACE), AND
43 SIXTH AVE., PITTSBURGH, PA.

ELECTRIC CONDENSERS

WM. MARSHALL, MANUFACTURER.

Standards a Specialty.

Rooms 2 and 4, University Building, New York.

THE LEHIGH VALLEY

CREOSOTING CO.

WORKS, PERTH AMBOY, N. J.

Office, Foot of Washington Street, JERSEY CITY, N. J.

Creosoted Lumber, Underground Conduits, Telegraph Poles, Piling and Ties Furnished.

HYDRAULIC PRESSES,

ALL VARIETIES.

PUMPS, VALVES, GAUGES AND FITTINGS,
PUNCHES, SHEARS, BUFFING MACHINERY, &c.

WATSON & STILLMAN,

210 EAST 43D STREET, NEW YORK CITY.

Special Attention to Electrical Work.

THE STANDARD OPEN CIRCUIT BATTERIES OF THE WORLD!

For 20 years these Batteries have maintained their superiority over all others and stand to-day unequalled and unapproachable. Refuse to take any cell unless it bears the Trade Mark, "Gonda."

THE LECLANCHÉ BATTERY CO.,

NEW YORK.

The Only PERFECT INSULATING SYSTEM FOR UNDERGROUND ELECTRIC WIRES is the

INDURATED FIBRE PIPE,

STRONG, Durable, Absolutely Proof against Moisture, ✳ ✳

✳ ✳ The Action of Acids and Gases of the Earth.

SUBJECTED TO EVERY PRACTICAL TEST.

UNDERGROUND FOUR YEARS WITHOUT DETERIORATION.

ADDRESS, FOR INFORMATION,

THE INDURATED FIBRE PIPE COMPANY,

Factory, Mechanicsville, N. Y. **Office, 40 Wall Street, NEW YORK.**

THE ELEKTRON MANUFACTURING CO.,

79-81 WASHINGTON STREET, BROOKLYN, N. Y.,

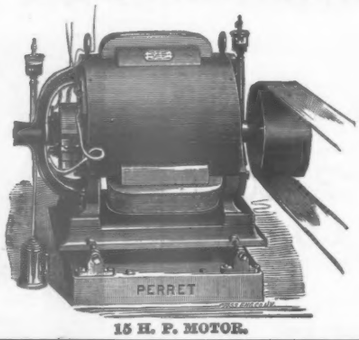
MANUFACTURERS OF

PERRET AUTOMATIC ELECTRIC MOTORS AND DYNAMOS.

EMBODYING LATEST IMPROVEMENTS

And all Desirable Features.

High Standard of Workmanship,
High Efficiency,
Low Speed, Perfect Regulation,
Simplicity.



15 H. P. MOTOR.

MOTORS
FOR RUNNING
Shops, Elevators and Machinery
OF ALL KINDS.

FAN OUTFITS
—FOR—
Battery or Electric Light Circuits.

ISOLATED PLANTS for INCANDESCENT ELECTRIC LIGHTING.

HOLMES, BOOTH & HAYDENS,

MANUFACTURERS OF

BARE AND INSULATED WIRE,

Underwriters' Copper Electric Light Line Wire, handsomely finished, highest conductivity. Copper Magnet Wire, Flexible Silk, Cotton and Worsted Cords for Incandescent Lighting. Round and Flat Copper Bars for Station Work. Insulated Iron Pressure Wire.

TRADE MARK "K.K."

PATENT "K. K." LINE WIRE

TRADE MARK "K.K."

For Electric Light, Electric Railways, Motors, Telegraph and Telephone Use.

Agents for the WASHINGTON CARBON CO.,

FACTORIES: WATERBURY, CONN.

NEW YORK OFFICE, 25 Park Place,

THOS. L. SCOVILL, NEW YORK AGENT

AGENTS FOR

OKONITE TRADE MARK.

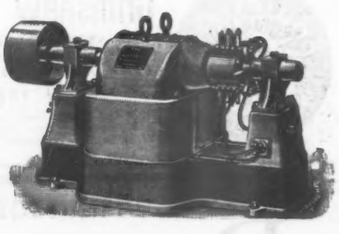
Wires, Tape and Cord, Candee Wire.

ELECTRICAL SUPPLIES.

Do You Want { The Best Goods / Good Prices / PROMPT SHIPMENTS } ?

IF YOU DO, WRITE US FOR QUOTATIONS.

AGENTS FOR THE CONNECTICUT MOTORS.



SOUTHERN ELECTRICAL SUPPLY COMPANY,

823 LOCUST STREET, ST. LOUIS, MO.

MOULDINGS

FOR ELECTRICAL WORK, IN ALL KINDS OF WOOD.

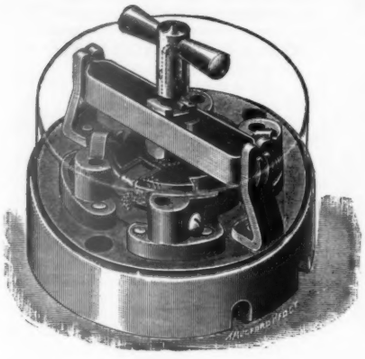
Office and Storehouse:
550 and 552 West 38th Street
NEW YORK.

Independent Bung Co.

Large Stock Always on Hand.

Factories:
Elizabeth, Wirt Co., W. Virginia,
and NEW YORK.

THE PERKINS ELECTRIC SWITCH MFG. CO.



Office, 314 Pearl St. HARTFORD, CONN. Factory, 302 Asylum St.

MANUFACTURERS OF

THE PERKINS INCANDESCENT SWITCHES.

Made with Porcelain Bases only.

No. 1.	Capacity up to	**10**	Amperes,	Single Pole.		
No. 2.	"	"	"	**15**	"	Double Pole.	
No. 3.	"	"	"	**30**	"	"	"
No. 4.	"	"	"	**40**	"	"	"
No. 5.	"	"	"	**75**	"	"	" } In
No. 6.	"	"	"	**100**	"	"	" } preparation.

Rated with continuous current; with alternating current their capacity is increased 50 per cent.

All parts made to gauge and interchangeable. Every Switch Guaranteed. Correspondence Solicited.

LIST OF DYNAMOS IN STOCK.

Designation of Machine.	No. Lights 2,000 c. p. 10 amp. X	No. Lights 1,000 c. p. 8 amp. Y	No. Lights 1,200 c. p. 6 amp. Z	No. Lights 800 c. p. 4 amp.	Horse-Power at Pulley of Dynamo.	Width of Single Belt in Inches.	Belt Speed Required.	Weight of Dynamo.
C	8	.....	.....	.....	6.5	1¼	5,000 FEET PER MINUTE.	530
C	.....	10	.....	.....	6.3	1⅝		530
C	.....	.....	.....	25	8.0	2		530
C	16	.....	.....	.....	12.0	2½		780
C	.....	20	.....	.....	12.5	2½		780
C	.....	.....	26	.....	13.0	2⅝		780
C	20	.....	.....	.....	15.0	3		990
C	.....	25	.....	.....	15.6	3		990
C	.....	.....	32	.....	15.0	3		990
C	.....	.....	.....	50	16.0	3		990
C	28	.....	.....	.....	21.0	4½		1,360

LIST OF DYNAMOS IN STOCK.

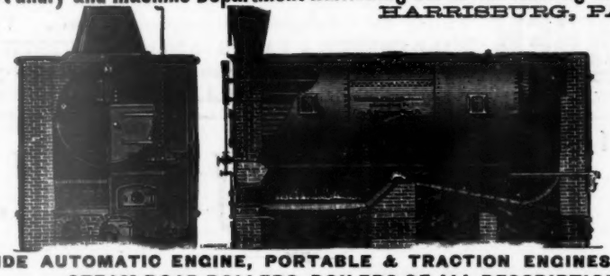
Designation of Machine.	No. Lights 2,000 c. p. 10 amp. X	No. Lights 1,000 c. p. 8 amp. Y	No. Lights 1,200 c. p. 6 amp. Z	No. Lights 800 c. p. 4 amp.	Horse-Power at Pulley of Dynamo.	Width of Single Belt in Inches.	Belt Speed Required.	Weight of Dynamo.
G	.....	35	.....	.....	21.0	4	5,000 FEET PER MINUTE.	1,360
G	.....	.....	45	.....	21.0	4		1,360
G	.....	.....	.....	70	21.0	4½		1,360
H	40	.....	.....	.....	29.7	6		1,750
H	.....	50	.....	.....	30.0	6		1,750
H	.....	.....	64	.....	29.5	6		1,750
I	52	.....	.....	.....	38.0	8		2,290
I	.....	65	.....	.....	38.6	8		2,290
I	.....	.....	83	.....	38.0	8		2,290
J	64	.....	.....	.....	46.5	10		2,770
J	.....	80	.....	.....	47.1	10		2,770
K	75	.....	.....	.....	52.5	12		3,200

Weitmyer Patent Furnace,

MANUFACTURED AND SOLD BY

Foundry and Machine Department Harrisburg Car Manufacturing Co.

HARRISBURG, PA.



IDE AUTOMATIC ENGINE, PORTABLE & TRACTION ENGINES.

STEAM ROAD ROLLERS, BOILERS OF ALL DESCRIPTIONS.

New York Office, Messrs. W. R. Fleming & Co., 174 Fulton Street.
New England Office, Messrs. John Post, Jr., & Co., 70 Kilby St., Boston.
Baltimore Office, Messrs. Thomas K. Carey & Bro., 36 Light St., Balt.

WESTERN OFFICE, MESSRS. ENGLISH, MORSE & CO., KANSAS CITY, MO.

THE
American Bell Telephone Company,

95 MILK ST., BOSTON, MASS.

This Company owns the Letters Patent granted to Alexander Graham Bell, March 7th, 1876, No. 174,465, and January 30, 1877, No. 186,787.

The Transmission of Speech by all known forms of ELECTRIC SPEAKING TELEPHONES infringes the right secured to this Company by the above patents, and renders each individual user of telephones, not furnished by it or its licensees, responsible for such unlawful use, and all the consequences thereof and liable to suit therefor.

INTRODUCING ENTIRELY NEW PRINCIPLES.

Pat. Mar. 19, 1889. THE OLD STYLE.

THE ACME LINK BELT

IS MADE ONLY BY THE

Page Belting Company, Concord, N. H.

BRANCHES: Boston, New York, Chicago, San Francisco. Also, manufacturers of all the staple grades of Leather Belting and Lacing. Send for Illustrated Catalogue—a valuable treatise on belting, Free.

TO AMERICAN INVENTORS.

Woodhouse & Rawson,

(UNITED, LTD.)

88 QUEEN VICTORIA STREET,

LONDON, ENG.,

New York Office, 36 Wall St.,

Are prepared to negotiate and introduce inventions of merit into Great Britain and all parts of the world.

CORRESPONDENCE INVITED.

The Only Watches for Electricians.

FOR SALE BY ALL JEWELERS.

Paillard Non-Magnetic Watch Co.,

192 BROADWAY, NEW YORK.

LEGAL NOTICE.

TO ALL TO WHOM THESE PRESENTS MAY COME, KNOW YE,

By a resolution duly passed by the Corporation known as "Hazazer & Stanley," it was voted to change the name of said Corporation, with permission of the Court, from "Hazazer & Stanley" to "Stanley & Hall."

Now, by order of the Supreme Court, it is made known that from this time the name of said Corporation is and shall be "Stanley & Hall."

A. F. STANLEY,
President.

New York, Sept. 20, 1890.

Sigourney Drills.

IMPROVED.

Sensitive, Strong and Interchangeable.
One, Two and Three Spindles.

GUARANTEED PERFECT.

Send for Price List "B."

The Sigourney Tool Co.,

HARTFORD, CONN.

WE STILL HAVE LAMPS, AND MORE ARE BEING MADE AT OUR FACTORY. NOTWITHSTANDING THE FACT THAT WE HAVE SOLD

THOUSANDS

DURING THE PAST WEEK,

THE

INCANDESCENT LAMP

WILL KEEP UP WITH THE PROCESSION, AND WE CAN PROMISE PROMPT SHIPMENTS. ANY VOLTAGE. ANY CANDLE-POWER. TO FIT ANY SOCKET.

ALEXANDER, BARNEY & CHAPIN,

GENERAL ELECTRICAL SUPPLIES,

20 Cortlandt Street, - - NEW YORK.

WRITE For the Electrical Review's *New Catalogue* of all Electrical and Scientific Books.
18 PARK ROW, NEW YORK.

JUST ISSUED FROM THE PRESS!

WHIPPLE'S

Electric, Gas and Street Railway

FINANCIAL REFERENCE

DIRECTORY

For 1890.

CONTENTS:

List of all Central Electric Light and Power Stations, with Capital Stock, Officers, Systems used, Capacity and Number of Lights in use, Steam Plants, Day Circuits, Kind of Wire and Belts used and Financial Standing.

List of all Isolated Electric Light Plants, with Number and Kind of Lights.

List of all Gas Companies, with Capital Stock, Officers, Price of Gas and Financial Standing, including all Gas Companies operating Electric Light Plants.

List of all Street Railway Companies, with Capital Stock, Officers, Miles of Track, Gauge, Kind of Rail, Number of Cars and Horses, Motive Power, if Electric, Cable or Steam, and Financial Standing.

List of all Telephone Exchanges and Licensed Companies, with Officers and Financial Standing.

Financial Standing of all Manufacturers, Dealers and Agents in the General Electrical World.

Price of all Public Lighting Contracts, with Number and Kind of Lights, Hours Burned, etc.

Rules and Requirements of all the Boards of Fire Underwriters, Insurance Companies, etc.

HANDSOMELY PRINTED AND BOUND.

Sent express paid on receipt of $5; with Monthly Corrections, $6; with Confidential Rate Sheet, $10.

THE FRED H. WHIPPLE CO.,

NEW YORK OFFICE, TEMPLE COURT. DETROIT, MICH.

WHEN Writing for Catalogues, Information or Prices, **YOU WILL CONFER A FAVOR** on both the **ADVERTISER** and the **PUBLISHER** by mentioning the fact that you saw the advertisement in the *ELECTRICAL REVIEW.*

"The Electric Railway of To-Day."

—BY—

H. B. PRINDLE,

OF BOSTON.

HANDSOMELY ILLUSTRATED.

THE SUBJECT POPULARLY TREATED.

An Able and Interesting and Timely Publication.

PRICE, 50 CENTS.

ADDRESS:

ELECTRICAL REVIEW,

13 Park Row, New York.

FARADAY CARBON CO.,
ELECTRIC LIGHT CARBONS, PITTSBURGH, PA.

ELECTRICAL MEASUREMENT

Instruments and Batteries of the Very Highest Grade.

Precision and Constancy, Quality and Finish the Best in the World.

Catalogue of Standard Test Instruments furnished upon application.

THE E. S. GREELEY & CO.,

5 AND 7 DEY ST., NEW YORK.

W. R. OSTRANDER & CO.

105 & 107 FULTON ST., NEW YORK.

Manufacturers of

SPEAKING TUBES, WHISTLES, ANNUNCIATORS, Electric and Mechanical Bells.

FACTORY, De Kalb Ave., BROOKLYN.

Send for Illustrated Catalogue.

Something New! One, two, three, and four spindle drills for light work.

DRILLS

The most useful patented improvement in drill presses for years is applied.

SENSITIVE

Spindles driven with single, endless belts. Large driving pulleys, tightener and variable speeds provided.

Over 1,000 in use. Buy the **latest** and **best**. Special machinery to order. Catalogue of fine tools free.

Dwight Slate Machine Co.

HARTFORD, CONN.

ROYCE & MAREAN,

DEALERS IN

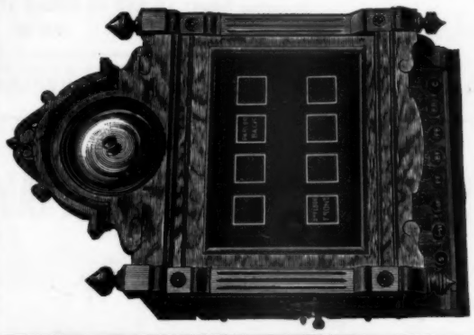
ELECTRICAL APPARATUS,

Telegraph and Telephone Supplies,

No. 1408 Penna. Avenue,

Opp. Willard's Hotel. WASHINGTON, D. C.

Manufacturers



H. E. & C. BAXTER,

18 FULTON STREET,

Brooklyn, N. Y.

WHEN Writing for Catalogues, Information or Prices, YOU **WILL CONFER A FAVOR** on both the **ADVERTISER** and the **PUBLISHER** by mentioning the fact that you saw the advertisement in the *ELECTRICAL REVIEW.*

SUNLIGHT CARBONS

THE

PARKER-RUSSELL MINING & MFG. CO.

MERMOD-JACCARD BUILDING,

Cor. Broadway and Locust St. Rooms 307 and 308.

ST. LOUIS.

UNIFORM IN QUALITY, LONG LIFE AND GOOD LIGHT

Dr. Gassner's Dry Battery

FOR

OPEN CIRCUIT WORK.

THE BATTERIES ARE NOW MADE IN THE FOLLOWING SIZES:

No.		Height.	Width.
18.	Rectangular (Double Cell),	7½ in.	3¾ in. x 3½ in.
17.	"	7½ "	3¾ " 1¾ "
16.	Cylindrical (Enameled)	7 "	3 in. diam.
15.	"	7 "	3 "
10.	"	5½ "	3 "
19.	Oval,	6½ "	3¾ in. x 1¾ in.
02.	Rectangular,	4½ "	2¼ " 1½ "

A. SCHOVERLING,

Sole Agent and Manufacturer,

111 Chambers Street, NEW YORK.

Washburn & Moen Mfg.

WORCESTER, MASS.

MAKERS OF

IRON AND STEEL

MANUFACTURERS OF

Iron and Copper Wire for Electrical Purposes.

PATENT GALVANIZED TELEGRAPH & TELEPHONE WIRE,

In Long Lengths, Galvanized by our Patent Continuous Process.

The Standard with all Telegraph and Telephone Companies.

Since the first introduction of the Electric Telegraph Service, our patent wire, expressly manufactured for electric purposes, has filled every requisition as regards strength, evenness of quality, and conductive capacity.

Send for Price Lists and descriptive pamphlets, and "Hand-book of Wire in Electric Service." Sent free on application.

New York Warehouse, 16 CLIFF STREET.

Chicago Warehouse, 107 & 109 LAKE ST.

NEW YORK BELTING AND PACKING CO.

LARGEST BELTS IN THE WORLD.

RUBBER BELTING, PACKING, HOSE,— —MATS, MATTING, STAIR-TREADS.

15 PARK ROW, NEW YORK.

(OPPOSITE ASTOR HOUSE.)

J. H. CHEEVER, TREAS. J. D. CHEEVER DEP'Y. TREAS.

GIVES MORE POWER USING LESS WATER THAN ANY OTHER WHEEL.

THE OLD RELIABLE —LEFFEL— WATER WHEEL

SEND FOR CATALOGUE.

JAMES LEFFEL & CO.

SPRINGFIELD, O., OR 110 LIBERTY ST., N.Y.

"Prices are low yet quality tells."

A Corliss Engine

well designed and thoroughly built, is the best the world today possesses.

The Lane & Bodley Co., Cincinnati, O., have a high ideal of what their engines should be, and invite their customers to say what they are. If you want an engine and never have seen one of these, write for descriptive circular.

THE LANE & BODLEY CO., CINCINNATI, O.

Electrical Testing Apparatus Manufactured to Order, Repaired or Calibrated.

WESTERN ELECTRIC CO., NEW YORK.

ARC LAMPS FOR INCANDESCENT CIRCUITS.

THE UNIVERSAL ARC LAMPS. These lamps are intended for direct current circuits, giving a steady and noiseless light, and can be adjusted for circuits having a pressure from 100 to 125 volts, using from eight to nine amperes; when burning two in series, the resistance is coiled about the chimney at the top of each lamp, within which the carbon rod is suspended, thereby rendering any additional resistance unnecessary.

Electric light stations and owners of isolated plants using low potential currents will do well to examine this lamp before purchasing elsewhere, as our claim for the lamp is that it is the best article in the market.

THE UNIVERSAL THEATRICAL ARC LAMP. This lamp is manufactured for stage uses, taking the place of the calcium lights, and can be used wherever constant direct circuits exist; it can be easily handled and has all the effects of the calcium, and the cost of running same being very much cheaper than the old-fashioned method. We are prepared to furnish complete outfits at shortest notice; prices and references on application.

FOR PRICES AND FURTHER INFORMATION, APPLY TO

THE UNIVERSAL ARC LAMP CO.,

Executive Office: 16 AND 18 BROAD STREET. Salesrooms: 49 WEST 22d STREET.

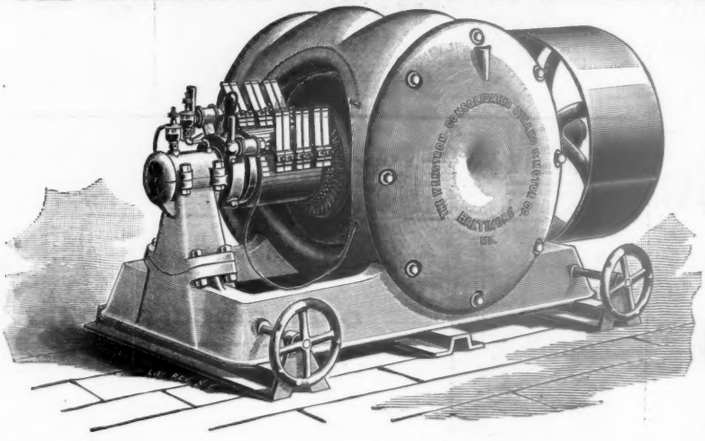
J. H. McCLEMENT, President. NEW YORK. E. S. MENDELS, General Manager.

OR TO

THE ELECTRICAL SUPPLY CO., Chicago, Ill. ST. LOUIS ELECTRICAL SUPPLY CO., St. Louis, Mo. SOUTHERN ELECTRICAL MFG. & SUPPLY CO., Limited, New Orleans, La. WALKER & KEPLER, Philadelphia, Pa. PETTINGELL-ANDREWS CO., Boston, Mass.

THE WENSTROM CONSOLIDATED DYNAMO AND MOTOR CO., OF BALTIMORE, MD.,

MANUFACTURERS OF



ELECTRICAL APPARATUS,

ELECTRIC MOTORS FOR ALL WORK,

Dynamos for Incandescent Lighting.

SPECIAL FEATURES:

High Efficiency. ✳ Slow Speed.

For full information and circulars address,

CHADBOURNE, HAZELTON & CO.,

SOLE SELLING AGENTS FOR U. S.,

416-420 WALNUT ST., PHILADELPHIA.

AGENTS WANTED IN ALL LEADING CITIES.

BUY THE

SCHUYLER APPARATUS

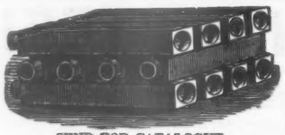
IF YOU WANT THE BEST

Arc Lighting System.

Office and Factory:

MIDDLETOWN,

CONN.



SEND FOR CATALOGUE.

THE WYCKOFF PIPE CO.,

MANUFACTURERS OF

WOODEN PIPES FOR

UNDERGROUND ELECTRICAL WIRES.

We have large works for creosoting Lumber, R. R. Ties, Telegraph Poles, &c., &c.

WILLIAMSPORT, PENN.

SUBSCRIBE NOW FOR THE ELECTRICAL REVIEW.

Norway Iron Frame

ELECTRIC BELL

IS THE

CHEAPEST AND BEST.

Send for Illustrated Circular of Bells and

Other Electrical Goods.

J. ELLIOTT SHAW & CO.,

632 ARCH ST., PHILA.

A LIBRARY FOR $1.00

Five books in one. Worth its weight in gold to every mechanic. The very latest information for 20 different trades. This wonderful book contains 575 pages absolutely teeming with rules, tables, secret processes, and new information that cannot be had elsewhere for less than $25.00. The Modern Steam Engine—How to Read an Indicator—The Westinghouse Air Brake—Blacksmith's and Machinist's Tools—Practical Mathematics Simplified—Tin and Sheet Iron Worker's Manual—Carpenter's Manual—Points for Painters—Magnetism and Electricity—How to Get a Patent—A Mechanical Dictionary. Everything fully explained in one handsome volume and guaranteed to be absolutely correct. Send $1.00 for a copy bound in silk cloth, or $1.50 for Morocco binding. With each copy of the book we give free a complete working chart for setting gear teeth. The regular price of this chart is $1.50. AGENTS WANTED. Write for terms. LAIRD & LEE, Publishers, 203 Jackson Street, Chicago, Ill.

Industries.

A Journal of Engineering, Electricity and Chemistry

— FOR THE —

MECHANICAL AND MANUFACTURING TRADES.

PUBLISHED EVERY FRIDAY.

ANNUAL SUBSCRIPTIONS.	Thick Paper.	Thin Paper.
GREAT BRITAIN, Post Free	$6 00	$6 00
THE UNITED STATES, CANADA and COUNTRIES INCLUDED IN THE POSTAL UNION, Post Free	9 00	8 00
INDIA, CEYLON, STRAITS SETTLEMENTS, CHINA, JAPAN, &c., Post Free	10 75	9 00

SUBSCRIPTIONS PAYABLE IN ADVANCE TO

GEO. CAWLEY, 358 STRAND, LONDON, W. C.

Manchester, 70 Market St.; Glasgow, 93 Hope St.; Yokohama (Japan), 32 Main St.

American Subscriptions to "Industries" are received by the Publisher of the ELECTRICAL REVIEW, 13 Park Row, New York.

CENTRAL ELECTRIC CO.

GENERAL DEALERS IN

ELECTRICAL SUPPLIES,

Including ELECTRICAL, RAILROAD, TELEGRAPH, TELEPHONE AND ELECTRIC LIGHT GOODS.

116 and 118 FRANKLIN STREET, CHICAGO.

We are the GENERAL WESTERN AGENTS for

OKONITE

TRADE MARK

AND

IMPROVED CANDEE WIRES.

These Wires are so well known to the Trade that **CONVINCING** arguments are not necessary. Everybody knows what they are. Send your orders to us when you want the greatest moisture and acid-proof, or the King of Weather-proof Wires.

CENTRAL ELECTRIC CO.,

116 & 118 FRANKLIN ST., - - - CHICAGO.

CONNECTED BY PRIVATE WIRE WITH POSTAL TELEGRAPH CABLE CO.

UNITED ELECTRIC TRACTION COMPANY,

EXECUTIVE OFFICES, 115 BROADWAY, NEW YORK.

AGENCIES:

926 Drexel Building, Philadelphia. 111 Water Street, Pittsburgh, Pa. 456 Rookery Building, Chicago.

Electric Railways and Power Stations,

STATIONARY MOTORS, STORAGE BATTERIES.

DYNAMOS, 1 to 250 H. P. MOTORS, ½ to 100 H. P.

WORKS, JERSEY CITY, N. J.

GOOD GOODS. PROMPT SHIPMENTS. LOW PRICES.

GATE CITY ELECTRIC COMPANY,

Special Agents,

Manufacturers and Dealers in

Telegraph, Telephone, Electric Light

— AND —

GENERAL ELECTRICAL SUPPLIES.

OKONITE

TRADE MARK

GLOBES AND SHADES,

Glass and Porcelain Insulators

— AND —

Incandescent Lamps.

AND CANDEE WIRES, CABLES, TAPE AND TUBING.

522 DELAWARE STREET, - - - - - - - - KANSAS CITY, MO.

IMPORTANT INFORMATION TO THE TRADE.

We carry a large stock of House Supplies, including Annunciators, Speaking Tubes, Bells, Batteries, Push Buttons, etc.
We are the Eastern Agents for J. H. Bunnell & Co., of New York, and Sole Agents for the Carr Metal Co.'s Improved Zincs. Also sole New England Agents for

BUNNELL'S NO. 4 HOME MEDICAL BATTERY AND BURNLEY DRY BATTERY.

Send for Price List of our Novelties and Specialties. We are Manufacturers and Dealers in

Telegraph, Telephone, Electric Light and Gas Lighting Supplies.

OUR PRICES ARE ALWAYS THE LOWEST.

THE EASTERN ELECTRICAL SUPPLY AND CONSTRUCTION COMPANY,

No. 65 OLIVER STREET, - - - - - - - - - BOSTON.

THE "WARD" ARC LAMP

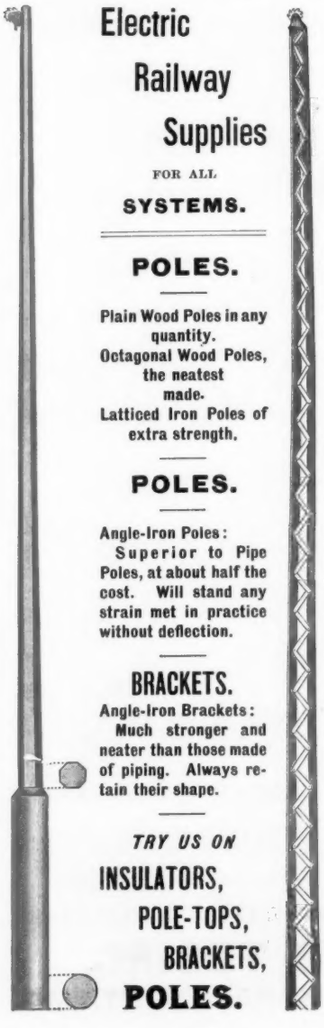
—FOR—

Incandescent Circuits—Continuous Current.

These Lamps are wound to pass 6½, 8 or 10 amperes of current, and when burning two in series on circuits of 100 to 125 volts, GIVE A CLEAR, STEADY LIGHT. We guarantee them. State system and voltage.

ELECTRIC CONSTRUCTION AND SUPPLY CO.,

18 CORTLANDT STREET, NEW YORK.



Electric Railway Supplies FOR ALL SYSTEMS.

POLES.

Plain Wood Poles in any quantity.
Octagonal Wood Poles, the neatest made.
Latticed Iron Poles of extra strength.

POLES.

Angle-Iron Poles: Superior to Pipe Poles, at about half the cost. Will stand any strain met in practice without deflection.

BRACKETS.

Angle-Iron Brackets: Much stronger and neater than those made of piping. Always retain their shape.

TRY US ON

INSULATORS, POLE-TOPS, BRACKETS, POLES.

GREAT WESTERN ELECTRIC SUPPLY CO.

GENERAL HEADQUARTERS FOR EVERYTHING ELECTRIC.

LOOK TO US FOR

STATION MATERIAL,
INSULATING MATERIAL,
CAR EQUIPMENTS,
LINE MATERIAL.

WE HAVE A FINE LINE OF

CONSTRUCTION TOOLS, POLE-HOLE AUGERS, IMPROVED TREE TRIMMERS, RAIL DRILLS, BLOW PIPES, COME-ALONGS, PULLEY BLOCKS, CLIMBERS, PLIERS.

FUSE WIRE.
Accurately tested for carrying capacity, in all sizes.
Also, Safety Strips and Cut-Outs in variety.

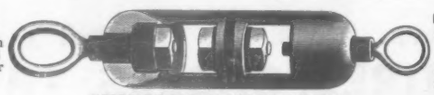
The Wire that gives the Highest Line Insulation.
FOR MAINS.
SIMPLEX
The Wire that pays best in the long run.
FOR FEEDERS.

BERNSTEIN LAMPS.
Consume little current and have long life. For any socket, any voltage. *Try them.*

SWITCHES.
Main and Branch Switches for Station Use.
Novel Snap Switch for use with lights.
The Best Overhead Switches.

INSULATORS.
New Trolley Insulator, extra light and strong, giving the best of insulation. Requires no soldering, and is quickly applied.

HEADLIGHTS.
For use overhead or on dashboard. Also, fusible Safety Switch for use with headlights.



"TREBLE" CENTER CURVE INSULATOR.
Combines Greatest Strength and Highest Insulation.

Trailer Connection
For lighting tow-cars. New design, with dead ends. No more grounds or shocks.

190-192 FIFTH AVENUE, CHICAGO.

NOISELESS ARMATURE PINIONS.
Our special make will outwear rawhide several times, and still have a lower first cost.

ARMATURE BEARINGS.
GIVE US A TRIAL ORDER.

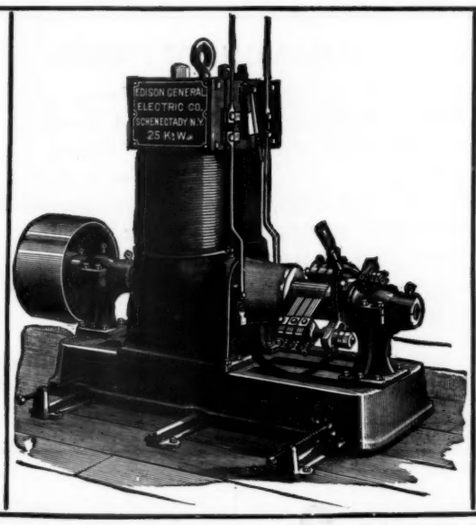
CAR FIXTURES.

We are the designers and makers of the only artistic ones in the market. Send for cuts and prices.

Finest Assortment —OF— STATION FIXTURES

EDISON
ELECTRIC MOTORS.

NOTICE!
REDUCTION IN PRICES!!



H. P.	LIST PRICE.	PRICE TO PURCHASER.
		45 per cent. off list price.
¼	$68.79 (no rheostat.)	$37.84
½	106.85 (no rheostat.)	58.76
1	194.23 (including rheostat.)	106.83
2½	321.85 " "	177.02
5	506.85 " "	278.77

SUBJECT TO CHANGE WITHOUT NOTICE.

PRICES OF LARGER SIZES OF MOTORS FURNISHED ON APPLICATION.

Write for Circulars and Quotations to Nearest District Office or any Electrical Supply House.

EDISON GENERAL ELECTRIC COMPANY.

MAIN DISTRICT OFFICES:

Canadian District, Bank of Commerce Building, Toronto, Can.
Central District, Rialto Building, Chicago, Ill.
Eastern District, Edison Building, Broad Street, New York.
New England District, 38 Pearl Street, Boston, Mass.
Pacific Coast District, 112 Bush Street, San Francisco, Cal.
Pacific Northwest District, Fleischner Building, Portland, Ore.
Rocky Mountain District, Masonic Building, Denver, Col.
Southern District, Cotton Exchange Building, New Orleans, La.

FORT WAYNE ELECTRIC COMPANY,

FORT WAYNE, IND.

MANUFACTURERS OF THE

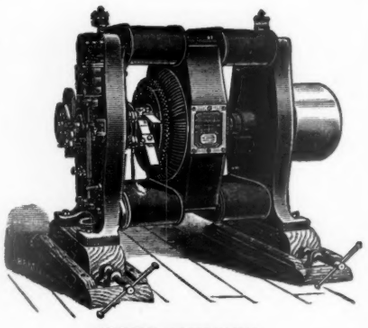
Slattery Induction System of Long Distance Incandescent Lighting

AND THE

Wood Automatically Regulating

ARC DYNAMO AND LAMPS.

Main Office, FORT WAYNE, IND.



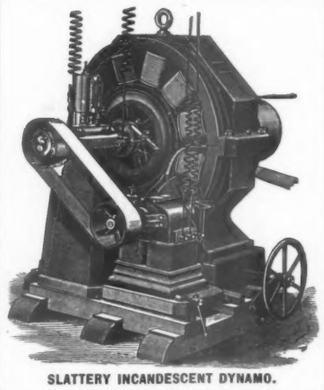
WOOD DYNAMO.

BRANCH OFFICES:

NEW YORK, -	115 Broadway.
PHILADELPHIA,	907 Filbert Street.
PITTSBURGH, PA.,	533 Wood Street.
CHICAGO, - -	185 Dearborn Street.
SAN FRANCISCO,	35 New Montgomery Street.
DETROIT, MICH.,	57 Gratiot Avenue.
TORONTO, CANADA,	138 King Street.
MEXICO, F. Adams' Successors,	City of Mexico.

FACTORIES:

FORT WAYNE, - - - -	INDIANA.
BROOKLYN, - - - -	NEW YORK.



SLATTERY INCANDESCENT DYNAMO.

THE

EMPIRE CITY ELECTRIC Co.

HELMET WATER PROOF WEATHER PROOF BRAND.

INSULATED WIRE.

Telegraph, Telephone & Electric Light WIRES AND CABLES.

HARDTMUTH EMPIRE CARBONS.

HARD AND SOFT CORED.

Mason Primary Batteries.

HOUSE WORK MATERIAL.

Batteries, Wire, Bells, Push-buttons, Flexible Cord, Burglar Alarms, Etc., Etc.

ELECTRIC LIGHT MATERIAL.

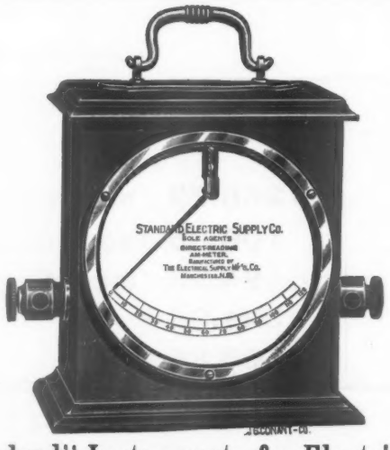
Poles, Cross-arms, Pins, Insulators, Brackets, Switches, Cut-outs, Lamps, Fixtures, Shades, Shade-holders, Etc., Etc.

ALL KINDS OF

ELECTRICAL SUPPLIES

Send for Wire Price-List and Catalogue to

The Empire City Electric Co., 15 Dey Street, N. Y.



The "Standard" Instruments for Electric Testing.

VOLTMETERS AND AMMETERS FOR CENTRAL STATION, LABORATORY & BATTERY WORK.

WE GUARANTEE OUR INSTRUMENTS CORRECT, AS EACH INSTRUMENT IS CAREFULLY CALIBRATED BEFORE LEAVING THE LABORATORY, AND WE FURTHER GUARANTEE TO KEEP THEM IN CALIBRATION IF SENT TO US FOR THAT PURPOSE.

TO SUM IT UP.

OUR "STANDARD" VOLTMETERS AND AMMETERS FILL THE LONG FELT WANT FOR A LINE OF INSTRUMENTS COMBINING ACCURACY, BEAUTY AND, MORE ESPECIALLY, REASONABLENESS IN PRICE.

WE SOLICIT YOUR CORRESPONDENCE.

A SPECIAL LINE OF VOLTMETERS FOR RAILWAY WORK AT LOW FIGURES.

PRICES QUOTED ON APPLICATION.

STANDARD ELECTRIC SUPPLY CO.,

180 SUMMER STREET, BOSTON, MASS., SOLE AGENTS.

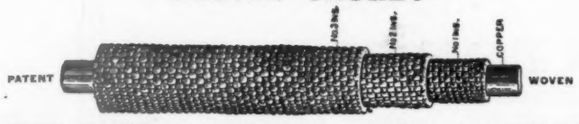
THE HIGHEST

ABRASION-RESISTING AND STRONGEST WIRES IN EXISTENCE

— ARE THE —

AMERICAN CIRCULAR LOOM COMPANY'S

"CANVAS JACKET"



INSULATED WIRES AND CABLES,

BOSTON: 620 ATLANTIC AVENUE.

SELLING AGENTS:

NEW YORK.—B. and S. Elec. Equipment Co., 115 Broadway.
CHICAGO.—Illinois Elec. Material Co., 341 Rookery Building.
PHILADELPHIA.—Clay & Pepper, 1218-1220 Filbert Street.
PITTSBURGH.—Mill and Mine Elec. Equipment Co., 95 Fifth Ave.

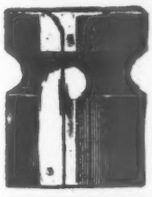
AN EXCELLENT ARTICLE.

The P.&B. TRADE MARK REGISTERED INSULATING TAPE.

MANUFACTURED ONLY BY

THE STANDARD PAINT CO.,

59 Maiden Lane, New York.



Porcelain Electrical Supplies and Specialties,

MANUFACTURED BY

EMPIRE CHINA WORKS,

144 & 156 Greene St., GREENPOINT, BROOKLYN, E. D., N. Y.

Our Ware is HARD PORCELAIN, the BODY and GLAZE IDENTICAL, and GUARANTEED NON-CONDUCTIVE for all ELECTRICAL PURPOSES.

BOOKS ON ELECTRICAL SUBJECTS

Will be mailed to any address, postage prepaid, on receipt of price. Address,

ELECTRICAL REVIEW PUB. COMPANY,

13 Park Row, New York. P. O. Box. 3,329.

NEW ENGLAND BUTT CO.,

PROVIDENCE, R. I., U. S. A.,

MANUFACTURERS OF

BRAIDING MACHINERY

FOR COVERING

TELEGRAPH,

TELEPHONE

AND

Electric Light Wire,

LARGE SINGLE AND DOUBLE

BRAIDERS

FOR COVERING CABLES

Single, Double and Triple

WINDERS,

Horizontal and Upright

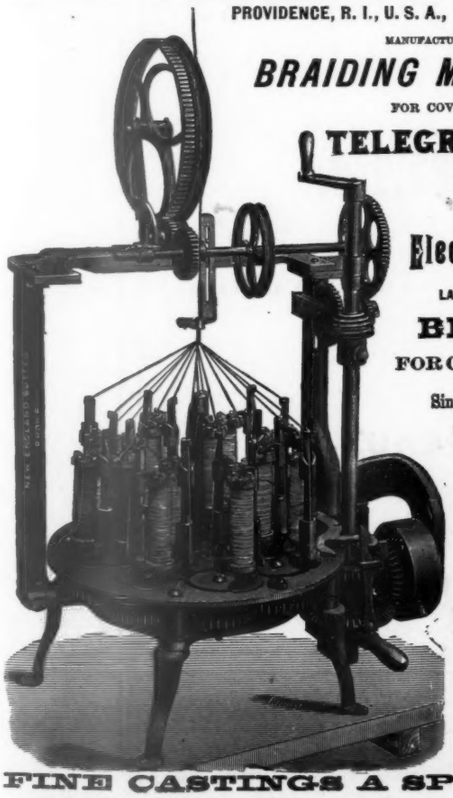
Taping Machines,

Cabling Machines,

Measuring Machines,

Stranding Machines,

Etc., Etc.



FINE CASTINGS A SPECIALTY.

"ELECTRICITY IN DAILY LIFE."

A POPULAR ACCOUNT

— OF THE —

APPLICATIONS OF ELECTRICITY

TO EVERY DAY USES.

TASTEFULLY BOUND

— AND —

HANDSOMELY ILLUSTRATED.

A HANDSOME HOLIDAY GIFT BOOK for the Electrical Fraternity to present to their friends or to buy for themselves.

PRICE, $3.00.

Address,

ELECTRICAL REVIEW PUBLISHING CO.,

13 Park Row, New York.

TO INVENTORS:

The Electrical Review Patent Bureau

Conducts a General Soliciting Business, and is prepared to do thoroughly first-class work in procuring patents in the United States and all foreign countries.

THE MANAGER OF THE BUREAU

has had the advantage of a wide experience with electrical inventions, formerly in the Examining Corps of the Patent Office, where he was detailed to examine electrical inventions, and for the past three years as an active practitioner.

Correspondence is strictly confidential, and any readers of this journal who may desire any information relating to patents need have no hesitation in addressing the Patent Bureau.

Our aim is to give prompt and efficient assistance to inventors at moderate rates. We are gratified to be able to say that the Bureau enjoys the highest esteem of all inventors who have hitherto invited it to take charge of their patent interests.

REPORTS UPON PATENTABILITY OF INVENTIONS; INVESTIGATIONS OF QUESTIONS OF INFRINGEMENT or VALIDITY OF PATENTS ALREADY ISSUED; PROSECUTION OF APPLICATIONS; EXPERT ADVICE IN RESPECT OF INVENTIONS, and all business relating to or depending upon patents is carefully attended to.

ELECTRICAL INVENTIONS } Are a Special Feature.

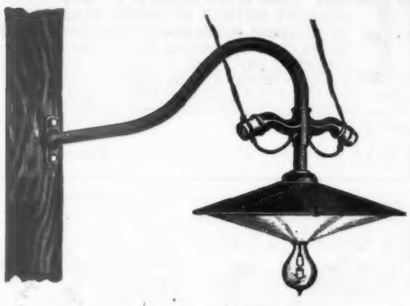
In this rapidly growing art, where inventors are constantly treading upon one another's heels, it is dangerous to defer steps to protect a patentable idea.

All communications should be addressed to the

MANAGER OF PATENT BUREAU,

Electrical Review,

13 Park Row, New York.



INCANDESCENT LAMPS FOR ARC LIGHT CIRCUITS

ESPECIALLY DESIRABLE FOR STREET AND STORE LIGHTING.

A NECESSITY TO EVERY LIGHTING CO. ✳ ALL OUTSIDE PARTS OF INSULATING MATERIAL.

INCANDESCENT LAMPS FOR MULTIPLE CIRCUITS

ANY VOLTAGE. CAPPED FOR ANY SOCKET.

BERNSTEIN ELECTRIC CO.

620 ATLANTIC AVENUE, BOSTON, MASS.

NASSAU ELECTRICAL SPECIALTIES.

CAPSULE BATTERY.

(Patented Aug. 19, 1890.)

SMALLEST EFFECTIVE BATTERY IN EXISTENCE.

PERFECTLY DRY.

Does not Require Wiring.

Never Polarizes.

Power Constant.

Sample by mail, $1.10.

ELECTRICAL BELL OUTFIT.

(Patented Aug. 19, 1890.)

The Simplest and Most Complete Portable Bell Outfit in the market. The bell is operated by the Nassau Capsule Battery, concealed in the case of the push button.

This battery is not connected by wires and can by withdrawn and replaced by the user instantaneously when a renewal is necessary.

Electric Alarm Thermometer.

(Patented Aug. 19, 1890.)

This thermometer sounds an alarm whenever the temperature rises above or falls below any required point.

It is designed for use in Offices, Schools, Hospitals, Living Rooms, Baths, Breweries, Factories and all places where the maintenance of an equable temperature is desirable.

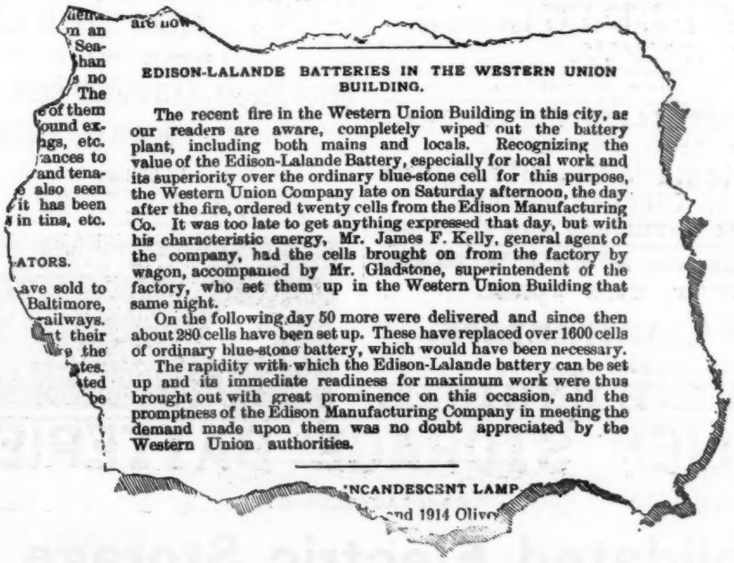
It can be arranged to sound at any distance from the thermometer, and can thus be used as an infallible guard against fire.

NASSAU ELECTRICAL CO., 19 Park Place, New York.

THE NEW EDISON-LALANDE BATTERY.

MANUFACTURED UNDER AUTHORITY OF

THOMAS A. EDISON.



EDISON-LALANDE BATTERIES IN THE WESTERN UNION BUILDING.

The recent fire in the Western Union Building in this city, as our readers are aware, completely wiped out the battery plant, including both mains and locals. Recognizing the value of the Edison-Lalande Battery, especially for local work and its superiority over the ordinary blue-stone cell for this purpose, the Western Union Company late on Saturday afternoon, the day after the fire, ordered twenty cells from the Edison Manufacturing Co. It was too late to get anything expressed that day, but with his characteristic energy, Mr. James F. Kelly, general agent of the company, had the cells brought on from the factory by wagon, accompanied by Mr. Gladstone, superintendent of the factory, who set them up in the Western Union Building that same night.

On the following day 50 more were delivered and since then about 280 cells have been set up. These have replaced over 1600 cells of ordinary blue-stone battery, which would have been necessary.

The rapidity with which the Edison-Lalande battery can be set up and its immediate readiness for maximum work were thus brought out with great prominence on this occasion, and the promptness of the Edison Manufacturing Company in meeting the demand made upon them was no doubt appreciated by the Western Union authorities.

Edison Manufacturing Company,

JAMES F. KELLY, General Sales Agent, 19 DEY STREET, NEW YORK.

BARNES' NEW SENSITIVE DRILL

Speed, from 0 to 1600 revolutions without stopping the machine or shifting belts.

This new sensitive drill embodies principles not found in other tools of its class, is simpler in construction and more effective in operation than any sensitive drill in the market.

The speed of the drill spindle can be ***increased or diminished instantly,*** or the ***motion reversed*** without stopping the machine or ***shifting belts.***

More or less driving power can be applied to the drill spindle, as the size of the drill or the nature of the work may demand.

We claim for this drill superiority both in simplicity of construction, which renders it less liable to derangement, and in effectiveness of operation, on account of the variation of speed and power being so completely under the control of the operator, whereby all the adjustments are made with the least possible loss of time. It is smooth and almost noiseless in operation, and entirely free from the vibratory motion commonly found in drills of this class, where the spindle is driven by belt.

Sold subject to trial, with single or multiple spindle. Send for Catalogue.

W. F. & Jno. Barnes Co.
ROCKFORD, ILL.
Address, No. 419 Ruby Street.

Shultz Belting Company,

MANUFACTURERS OF
SHULTZ PATENT FULLED LEATHER BELTING AND LACE LEATHER
Office and Factory: Cor. Bismarck and Barton Sts., St. Louis, Mo.

Our Belting is made of leather tanned on the surface only; the interior (which is the fiber and strength of the hide) is not tanned but rawhide fulled and softened by our patent process. Our Belting is more pliable, hugs the pulley better, transmits more power than any other, and is the only perfect ELECTRIC LIGHT BELT MADE. Agents in all cities. Send for trial belt.

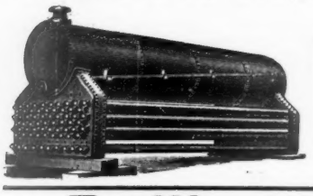
THE HEINE SAFETY BOILER CO.

PATENT SAFETY WATER TUBE STEAM BOILERS.

NO CAST IRON PARTS. ALL PLATE STEEL.

No contracted openings to drum, but full area of tubes carried out, thus assuring free circulation and dry steam. Adapted for all kinds of water and fuel. Manufactured both in the East and West. Send for Illustrated Catalogue.

707 Bank of Commerce Building, St. Louis, Mo.,



—OR TO—

Heine Safety Boiler Co.....82 Madison St., Chicago, Ill
Risdon Iron Works.....San Francisco, Cal.
Stearns, Roger & Co.....3 Duff Block, Denver, Col.
R. M. Huston.....Room 169, 45 Broadway, New York
Jos. K. Rugg & Co..107 West Second St., Cincinnati, O.
Van Zile, MacCormack & Co.....Albany, N. Y.
L. Metesser.....34 St. Charles St., New Orleans, La.
T. C. Gooch.....448 West Main Street, Louisville, Ky.
English, Morse & Co. 1221 Union Ave., Kansas City, Mo.
Seeger & Guernsey Co.....City of Mexico, Mexico.
Jas. H. Harris.....82 Madison Street, Chicago, Ills.

AGENTS.

THE WALKER ELECTRIC CO.,

MANUFACTURERS OF THE

WALKER ELECTRIC METER,

THE ONLY RELIABLE METER IN THE MARKET,

50 BROADWAY,

EDWIN SCOTT, President.
GEO. W. WALKER, Vice-Prest. & Gen'l Manager,
LEWIS G. TEWKSBURY, Sec'y and Treas.

NEW YORK, U. S. A.

POND ENGINEERING CO.,

ENGINEERS AND CONTRACTORS.
Complete Steam Plants for Electric Light and Power.
Engines, Boilers, Furnaces, Grates, Heaters, Pumps, Injectors, Pipe Work, Belting, etc., designed with special reference to the HIGHEST EFFICIENCY.
Our Extended Experience Enables us to Guarantee Satisfaction. Send for New Illustrated Pamphlet.
ST. LOUIS, CHICAGO, KANSAS CITY, OMAHA, DALLAS AND SEATTLE.

CHARLES R. VINCENT & CO.,

15 CORTLANDT STREET, NEW YORK,
Ball High Speed Automatic Cut-off Engines
MANNING VERTICAL TUBULAR BOILERS,
Complete Steam Plants Furnished and Erected.

WILLIAMS & POTTER,

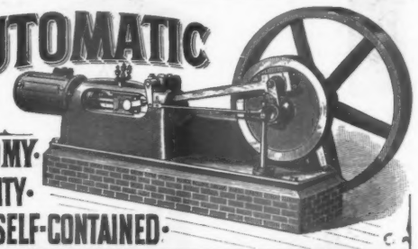
15 CORTLANDT ST., NEW YORK.
Engineers & Contractors,
GENERAL AGENTS,
STRAIGHT LINE ENGINES

MACKITE

AN IMPROVEMENT ON THE PRESENT METHOD OF ROUGH PLASTERING. Manufactured in any length slabs from 1-2 to 6 inches thick. Plastering done in one-tenth the time of old way, winter or summer. No waiting for walls to dry out. No dirt, as in case of plasterer's mortar. Less weight, less conductivity of cold or heat. Can be used for deafening, back-plastering, non-conducting or isolating partitions, furring, floors, roofs, etc. **FIRE-PROOF, EASILY TRANSPORTABLE.**

EASTERN PLASTER BOARD CO., 52 Broad St., New York.

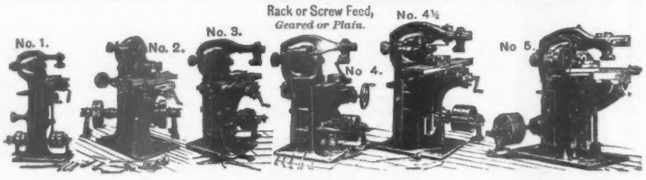
THE PICE AUTOMATIC



GUARANTEED
ECONOMY · REGULATION · DURABILITY · SIMPLICITY · SELF-CONTAINED ·
8 TO 300 H.P.
PAIR & TANDEM COMPOUNDS.
THE JOHN T. NOYE MFG CO. BUFFALO. N.Y.

FAIRBANKS, MORSE & CO., Western Representatives, Chicago, St. Louis, Kansas City, Omaha, Denver, St. Paul
ALBERT FISHER, 89 Liberty Street, New York, Eastern Agent.

OUR LINE OF PLAIN MILLING MACHINES.



THE GARVIN MACHINE COMPANY,

Manufacturers of, and Dealers in, all kinds of
MACHINERY AND MACHINE TOOLS.

Universal and Plain Milling Machines, Drill Presses, Screw Machines, Hand and Engine Lathes, Planers, Profilers, Chucking Machines,

Gear Cutters, Die and Cutter Grinders, Tapping Machines, Wire-Spring Coilers, Milling Cutters, &c.

Plants for Manufacturers of Sewing Machines & Electrical Goods.

GEAR-CUTTING AND MILLING IN ALL ITS BRANCHES.

Laight & Canal Sts. [Catalogue sent on Application.] NEW YORK.

Grimshaw Patented White Core WIRES and CABLES.

FIRE, ACID, AND WATERPROOF. *GRIMSHAW TAPE.*

GRIMSHAW WHITE CORE INSULATED WIRE

NEW YORK INSULATED WIRE Co.,
Sole Manufacturers,
649 & 651 BROADWAY, N. Y.

R. E. GALLAHER, Secretary.
J. W. GODFREY, Gen'l Manager
W. B. DOWSE, Treasurer.

EUREKA TEMPERED COPPER COMPANY,

NORTH EAST, PA.,

ONLY MANUFACTURERS OF PURE COPPER TEMPERED FOR

Brush Copper, Commutator Bars, Copper Wire, Gear Pinions, Bearings, Trolley Wheels.

WESTERN SALES OFFICE:
225 DEARBORN STREET, CHICAGO.

EASTERN SALES OFFICE:
35 BROADWAY, NEW YORK.

PHOSPHOR-BRONZE

INGOTS, CASTINGS & MANUFACTURES.
THE PHOSPHOR BRONZE SMELTING CO. LIMITED
512 ARCH ST. PHILADELPHIA PA. U.S.A.
ORIGINAL MANUFACTURERS OF PHOSPHOR-BRONZE IN THE UNITED STATES AND OWNERS OF THE U.S. PATENTS.

JULIEN STORAGE BATTERIES

MANUFACTURED BY

The Consolidated Electric Storage Company,

Exclusive Licensee of the Brush and Julien Storage Battery Patents.

FOR AGENCIES AND LICENSES, ADDRESS THE COMPANY,
120 Broadway, N. Y.

FOR BATTERIES, ADDRESS THE COMPANY,
926 Drexel Building, Philadelphia, Pa.

THE HOLTZER-CABOT ELECTRIC COMPANY

MANUFACTURERS OF

ALL KINDS OF ELECTRICAL SUPPLIES,

OFFICE:
111 ARCH STREET, BOSTON.

FACTORY:
BROOKLINE, MASS.

THE NATIONAL CARBON CO.

CLEVELAND, OHIO.

MANUFACTURERS OF

ELECTRIC LIGHT CARBONS AND BATTERY MATERIAL.

DUST PROOF BELLS.

STANLEY & HALL,

Formerly HAZAZER & STANLEY,

32 & 34 Frankfort Street, New York.

BROWNLEE & CO.,

DETROIT, MICH.

CEDAR POLES

For Electric Purposes.

THE LARGEST STOCK AND QUICKEST SHIPMENTS.

☞ Manufacturers of the Celebrated Octagonal Red Pine Poles for Electric Railways and Electric Lighting; also Manufacturers of Cross-Arms and Pins.

THE TUBES OF THE

INTERIOR CONDUIT AND INSULATION COMPANY

ARE ESPECIALLY APPLICABLE TO

ELECTRIC RAILWAY REQUIREMENTS.

A Simple Solution of the Wiring Problem for Public Buildings, Residences, Factories, Station Work, Cars, Underground Feeders, and all places where insulation is required.

INTERIOR CONDUITS.

Endorsed by the Leading Electricians, Electric Light Companies, Wiring Contractors, Architects, Builders and Boards of Fire Underwriters.

UNDERGROUND CONDUITS

Are equally successful, and afford Cheapness, High Insulation and Durability.

For Catalogue, Price List and General Information, address

INTERIOR CONDUIT AND INSULATION COMPANY,

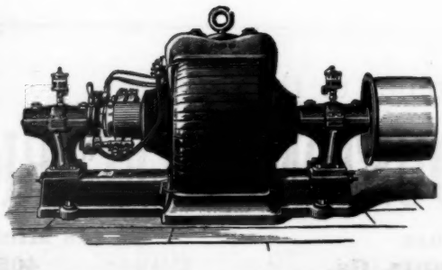
16 and 18 BROAD STREET, NEW YORK CITY. *EDWARD H. JOHNSON, Prest.*

"C. & C." ELECTRIC MOTORS.

The only Motors in which the magnetic circuit forms a perfect circle around the centre of the armature shaft. Thus making the most compact and efficient form of machine that can possibly be devised.

One-eighth horse-power to 50 horse-power in stock.

OVER 10,000 MOTORS IN ACTUAL OPERATION.



FAN OUTFITS.

Electric Blowers for Ship Ventilation.

MOTORS FOR HOISTS AND MINING TRAMWAYS.

Equipment of Machine Shops, Printing Offices, Factories and Entire Buildings, with Electric Power.

New England Office, 63 Oliver Street, Boston.
Philadelphia " 38 South Fourth Street.
Chicago " Phenix Building.

"C. & C." ELECTRIC MOTOR COMPANY,

402 & 404 Greenwich Street, New York.

THE

Thomson Recording Watt-Meter.

SIMPLE IN DESIGN AND CONSTRUCTION.

HAS NO AIR FAN.

HAS NOTHING TO WEIGH.

EASY TO INSTALL.

DIRECT READING.

LOW SPEED AND CONSEQUENT DURABILITY.

Accurate on one Lamp or Full Load. High Efficiency.

ADAPTED FOR CONTINUOUS OR ALTERNATING CURRENTS.

CAN BE USED ON ANY SYSTEM.

For Lighting Installations, 10, 25, 50, 100 and 150 Ampere Capacity, for 50, 75 and 100 Volt Circuits.

For Motor Installations, 25, 50, 100 and 150 Ampere Capacity, for 250 and 500 Volt Circuits.

Send For Illustrated Pamphlet to the

THOMSON-HOUSTON ELECTRIC COMPANY,

620 Atlantic Avenue, Boston, Mass.
Wall and Loyd Streets, Atlanta, Ga.
115 Broadway, New York City.
15 First Street, San Francisco, Cal.
266 First Street, Portland, Ore.
148 Michigan Avenue, Chicago, Ill.
405 Sibley Street, St. Paul, Minn.
215 West Fourth Street, Cincinnati, O.
1110 Noble Street, Philadelphia, Pa.
1333 F Street, Washington, D. C.
831 New York Life Building, Kansas City, Mo.

CONVERTER EFFICIENCIES.

It will PAY YOU to throw out your Present Converters and Substitute OUR MAKE.

COMPARISON OF CONVERTERS.

	TOTAL EFFICIENCY.	CONVERTER CAPACITY TESTED.
Thomson-Houston	87.50 per cent.	25
Ft. Wayne Jenney	87. "	25
National,	88. "	20
WESTINGHOUSE	95. "	20

WESTINGHOUSE ELECTRIC AND MANUFACTURING CO.,

PITTSBURGH, PA., U. S A.,

BOSTON, NEW YORK, CHICAGO, CINCINNATI, ST. LOUIS,
SAN FRANCISCO, CHARLOTTE, N. C. PORTLAND.

SOUTH LAKEWOOD PARK

THE ELECTRIC CITY.

ADJOINING LAKEWOOD, NEW JERSEY.

Lots 50 x 100, also plots from one-fourth acre to one acre, with young growing Oaks and Pines which can be trimmed to suit purchaser.

Land dry and elevated, 40 feet higher than Lakewood.

Climate the most suitable for a winter home.

The demand for winter homes is unprecedented and we fear that the extent of territory from Lakewood to Manchester will not be sufficient to meet the demand.

We have, therefore, raised the price of lots to **$250** until further notice. Town restricted to the very best.

Send for maps and particulars. Apply to or address,

Dr. DeLERY, Manager,

5 & 7 DEY STREET.

GENUINE TELEPHONES FOR EXPORT.

THE TROPICAL AMERICAN TELEPHONE COMPANY,

Sole Authorized Exporters to South America, Central America and West Indies.

AMERICAN BELL TELEPHONES, BLAKE TRANSMITTERS AND MAGNETOS.

TROPICAL AMERICAN TELEPHONE SETS AND SWITCHBOARDS OF ALL SIZES.

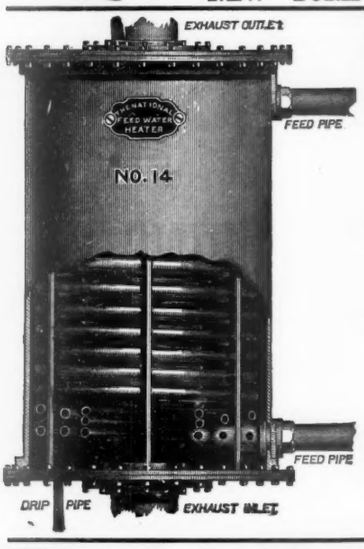
A NEW TELEPHONE SET FOR EXPORT, JUST OUT, PRICE, $15.00.

Old Switchboards and Magneto Call Bells Exchanged for New.

PATENTED TELEPHONIC APPARATUS AND SUPPLIES OF ALL SORTS AT LOWEST PRICES.

Send for New Catalogue, Price List and Pamphlet to

NEW YORK OFFICE, 18 CORTLANDT STREET, or BOSTON OFFICE, 95 MILK STREET.



The National Feed-Water Heater.

Over 300,000 Horse Power in use in the United States.

200 ELECTRIC LIGHT STATIONS SUPPLIED.

PRICES LOW. SATISFACTION UNIVERSAL.

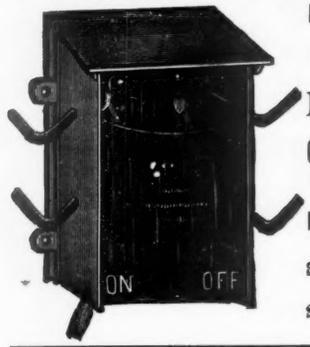
Seventeen sizes Manufactured, 8 to 2,000 Horse Power Capacity. Heats the Water for the Boilers up to 206° to 212° F.

SEND FOR LIST OF USERS AND EXAMINE FOR YOURSELF.

THE NATIONAL PIPE BENDING CO.,

84 River Street, New Haven, Conn.

THE E. S. GREELEY & CO.,



Nos. 5 & 7 Dey St., New York

Manufacturers and Importers of and Dealers in

Telegraph, Telephone — AND — Electric Light Supplies

AGENTS FOR

Cleveland Arc Light Cut Outs & Gang Switches

Cleats, Rosettes, Moulding, Pins, Cross-Arms, Brackets. Insulating Tapes.

Rubber, Porcelain and Glass Insulators

WIRES OF ALL KINDS.

Silk & Cotton Covered Flexible Conducting Cord of various sizes for Incandescent Lighting.

Spikes, Pole Steps, Lag Screws, Drive Screws, Turn Buckles, Etc.

C. J. FIELD, M. E., Pres't and Chief Eng'r. W. D. MAC QUESTEN, Consulting Eng'r. J. B. CRAVEN, Asst. Eng'r. E. F. WHITE, M. E., V. P. and Mech. Eng'r.
J. W. CRAWFORD, Secretary. F. UHLENHAUT, Jr., M. E., Asst. Eng'r. F. BOURNE, Electrical Eng'r.

Field Engineering Company,

15 CORTLANDT STREET, NEW YORK.

Consulting and Contracting Engineers. Complete Equipment of Electric Street Railways.

STEAM POWER PLANTS. STATION CONSTRUCTION. CONDUITS.

HILL'S

DOUBLE-POLE CONVERTER SWITCH

Opens both Poles of Primary Circuit,

THEREBY AVOIDING ALL DANGER

WHILE WORKING ON THE

Converter or on the Secondary Circuit.

W. S. HILL,

133 OLIVER ST., BOSTON, MASS.

ELECTRICAL ACCUMULATORS.

Useful and Economical for all Purposes to which Electricity is Applicable, such as Propulsion and Lighting of Street Cars, Vehicles, Yachts, Etc.

Central Station and Isolated Lighting,
Portable Lighting or Power,
Portable Electric Lanterns,
Electric Power for Motors,
Portable Electric Fans for Office, Family and Sick Room.

Only Clean and Convenient Battery for Surgeons, Dentists and Professional Men generally.

Manufactured Exclusively under the Patents of

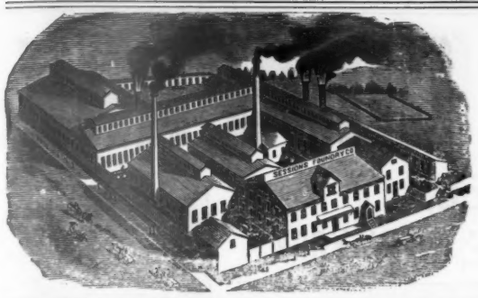
FAURE, SWAN, SELLON, GRISCOM and others.

COMPLETE ELECTRIC LIGHT & POWER PLANTS.

THE ACCUMULATOR COMPANY,

44 BROADWAY, NEW YORK.

PHILADELPHIA AGENCY:
ELECTRO DYNAMIC COMPANY, 224 Carter Street, Philadelphia, Pa.
CHICAGO AGENCY: 239 La Salle St. SAN FRANCISCO AGENCY: 220 Sutter St.
BOSTON AGENCY: HOLTZER-CABOT ELECTRIC COMPANY, 111 Arch St.
PROVIDENCE AGENCY: SWARTS & GANNETT, Swarts Building.



IRON CASTINGS FOR ELECTRICAL PURPOSES.

We cast Dynamo Magnets of a special mixture of iron that gives much better electrical results than ordinary castings. Also, small castings for Electrical Work, and castings large and small, for all purposes, of finest quality. OUR PRICES ARE LOW. We run four large cupolas constantly, melting about 35 tons daily. Correspondence solicited.

SESSIONS FOUNDRY CO., Bristol, Conn.

THE BRODIE TREE INSULATOR

CAN BE SET
AT ANY ANGLE DESIRED,
MAKING ALWAYS
Perfect Insulation for Wires,
Manufactured and Sold by
H. E. Swift Manufacturing Co.,
34 OLIVER ST., BOSTON, MASS.

New Tangye Buckeye Automatic Cut-off Engines.

In Use, Over 2,500.

25 to 1,000 H. P.

These engines are the combined result of long experience with automatic cut-off regulation, and most careful revision of all details. They are designed and constructed for heavy and continuous duty at medium or high rotative speeds. Highest attainable Economy in Steam Consumption and Superior regulation guaranteed. Self-contained Automatic Cut-off Engines 12 to 200 H. P. for driving Dynamo Machines a Specialty. Illustrated Circulars, with various data as to practical Steam Engine Construction and performance, free by mail

Address BUCKEYE ENGINE CO., Salem, Ohio.

SALES AGENTS:
W. L. SIMPSON, 10 Telephone Building, 18 Cortlandt Street, N. Y.
W. H. ROBINSON, 154 Washington St., Chicago, Ill. Robinson & Cary Company, St. Paul, Minn

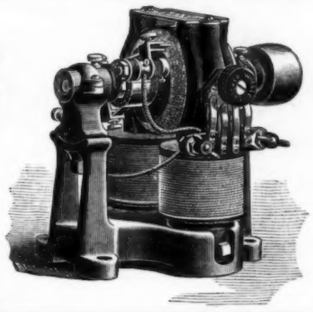
THE CLARK ARC LIGHTING SYSTEM

Is the Safest and Most Economical in the United States.

Manufactured by the CLARK ELECTRIC CO., 192 Broadway, N. Y.

THE CROCKER-WHEELER

PERFECTED
MOTORS.



VERY SLOW SPEED—FULL POWER—PERFECT REGULATION—FORGED FIELDS, LET INTO BASE—SELF-OILING BEARINGS—SELF-CENTERING BEARINGS—ALL SIZES—BOTH ARC AND INCANDESCENT—FOR ALL POWER PURPOSES.

Acknowledged by the leading Manufacturing Companies to be

THE MOST PERFECT MOTOR MADE.

Estimates and Plans Furnished for Electric Power Equipment.

CORRESPONDENCE INVITED.

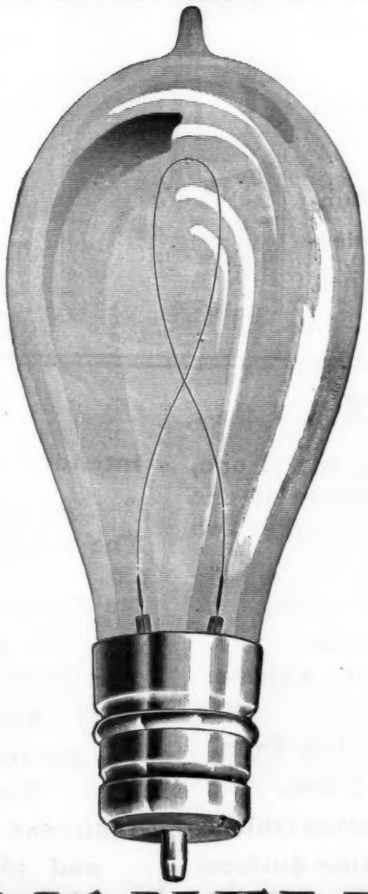
430-432 WEST 14TH STREET, NEW YORK.

S. S. WHEELER, President. F. B. CROCKER, Vice-Pres't.

INCANDESCENT LAMPS

To Fit any Socket.

Excelling all others in Life, Maintenance of Candle-Power and Efficiency.



Even Diffusion of Light by Twisted Filament.

From 8 Candle-Power to 150 Candle-Power and any Voltage.

THE BEST IS

General Electrical Supplies of Superior Design and Finish.

THE CHEAPEST

Send for Our Catalogue of August 1st, 1890.

SAWYER-MAN ELECTRIC CO.

620 Atlantic Avenue, BOSTON, MASS.

510-534 WEST 23d STREET, NEW YORK.

217 La Salle Street, CHICAGO, ILL.

CROSBY ELECTRIC COMPANY.

PRINCIPAL OFFICE,
87 & 89 SOUTH FIFTH AVENUE, NEW YORK.

CROSBY DRY BATTERIES

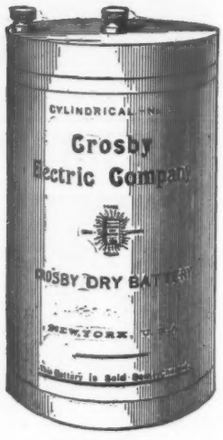
FOR OPEN CIRCUIT WORK.

ELECTRO-MOTIVE FORCE, 1.55 VOLTS. CURRENT, 1 TO 15 AMPERES.

RECTANGULAR, CYLINDRICAL, TELEPHONE.

MADE IN ALL SHAPES AND SIZES.

RECUPERATE OFTENER AND QUICKER THAN ANY OTHER.



NEAT. = CLEAN. = EFFECTIVE. = SIMPLE. = COMPACT. = PORTABLE.

IT IS THE BEST ON THE MARKET.
IT HAS MORE ADVANTAGES THAN ANY.
IT IS SOLD SEMI-CHARGED.
IT DOES NOT DIE ON THE SHELF.
IT IS NOT AFFECTED BY TEMPERATURE.
IT IS NOT DESTROYED BY SHORT CIRCUIT.
IT IS THE MOST RELIABLE.
IT PERFORMS THE MOST WORK.

FOR TELEPHONES, ANNUNCIATORS, GAS LIGHTING, HOUSEWORK, MEDICAL PURPOSES.

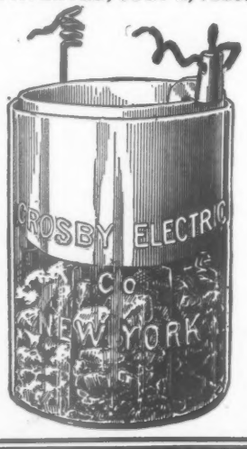
PATENTED, JULY 2, 1889.

THE HUSSEY BLUE STONE.

The Only Blue Stone Battery that can be used for open circuit work.

No Consumption of Blue Stone when not in use.

For Charging Storage Batteries, Running Sewing Machines, Small Incandescent Lamps, Fans, Dental Machines, Telegraphing.



Can be completely recharged without dismounting.

No Deposit of Copper on Zinc.

Gives 10 Times the Current of Any.

For Running Motors.

For All Uses.

THIS IMPROVEMENT CAN BE APPLIED TO ALL FORMS OF BLUE STONE JARS AT PRESENT IN USE.

THE DUPLEX.

Its two cells occupy only the space of one, thereby giving a voltage in the space of one cell, equal to that obtained by any other two cells requiring double the space.

**For Housework,
Bells,
Burglar Alarms,
Etc.**

No Climbing Salts.

Always Clean.

Recuperates Quickly.

Large Zinc Surface.

Is rapidly taking the place of all other Open Circuit Liquid Batteries.

THE ECLIPSE.

**Intended for Close Circuit Work.
Will Not Polarize.
Pure Water only Necessary to Charge It.
The Simplest and Cleanest Close Circuit Battery in the World.**

**No Fumes.
No Odor.**

**For Small Motors.
Small Lamps.**

For Doctors' and Dentists' Use.

Induction Coils, Etc., and all purposes where a Constant Current is required for continuous or intermittent work.